Perry Phillips, Big Bang: The Beginning of the Universe (Part 3) – Dark Matter, Multiverses and Other Difficulties

Biblicalelearning.org by Ted Hildebrandt

As the universe expands, we expect it to slow down. We expect it to slow down because gravity eventually begins to pull things in. Slow down the same way that if you throw something in the air, it slows down and then eventually turns back to Earth.

The question is whether there's enough matter in the universe to do that, which is illustrated by this bottom curve over on this side: is the mass critical, where it's not enough to cause a collapse of the universe, but will continue to go, continue to expand? Or is it what we call an open universe, where the expansion is so fast that the matter will spread out to the point where you don't have enough concentration to form galaxies, and stars, and people, and what have you? So the curvature of the universe is very important. But what was found, interestingly enough, is that as we look back in time at about 5 billion years ago, what we find is that the universe was accelerating. And this is caused by dark energy, which I will talk about somewhat later.

So that's what we observe. How much dark energy is there? What proportion of the universe is baryonic matter like us, dark matter, which we can't see, but we know is there, and dark energy? So we know from the investigation of the Hubble flow, the expansion of the universe, that the universe has been expanding, and we have the dark energy. But what about the dark matter? Here's a way we know that there's dark matter.

We're looking at a cluster of galaxies. And what we do when we look at a cluster like this is we look at the part that you can see, and you can calculate how much material is there by the way the clusters move, the galaxies in the cluster move. If you have more material, the clusters and the galaxies are closer together and moving around very rapidly.

If they're not very massive, then they don't move around quite as rapidly. But you can look at a cluster of galaxies like this and measure the speeds, figure out how much mass is there, and the result is there's not enough mass in the visible part of the galaxies that we see to cause the galaxy to stay together, the clusters to stay together. And so what we find is in a number of these clusters of galaxies, what we find is there's not enough material there to hold the galactic cluster together such that about a billion years after they formed, they already should have dispersed.

Something is there that holds the galaxy together that we can't see, that holds the cluster together that we can't see. By the way, that work was done back in the 30s by observations by Fritz Zwicky, who was Swiss and then came over to America. So the point is that, given what we can see in the galactic cluster- adding up all the mass that is there, looking at the speed of the galaxies- they're going far too fast for that cluster to have held together this long.

Something is there that is providing more mass that we can't see. But that's not the only place that we can see dark matter. Here's the Andromeda galaxy that is very much like ours would look if you were in the distance, this nice spiral galaxy.

And what we're going to do is we're going to put a coordinate system on here. We're going to measure the rotation speed of the material circling around the center of the galaxy as we move away from the center of the galaxy. And what we expect to happen is that the speed should drop.

It should be very similar to what we have in our solar system. Here's what our solar system looks like. The Sun is over here at zero.

And you have Mercury, Venus, Earth, Mars, Jupiter, Saturn, et cetera. And we look at the speed with which the planets are revolving around the Sun. And what you find is that the farther you get away from the Sun, where the gravitational field is less, the objects move more slowly around the Sun.

And this is exactly what we would expect looking at an individual galaxy, a spiral galaxy, such as we saw in the previous slide. But here's what you find. The speed stays the same.

It actually increases. And that particular work was done by Vera Rubin. And a little better graph; this is illustrative of what is going on.

This is totally contrary to what we expect. And the very fact that the outer parts of the galaxy are rotating just as quickly as the inner parts of the galaxy, again, there is something there. What is there? Here's the flat galaxy.

This is called the halo of the galaxy. There is a lot of material in the halo of the galaxy that we cannot see. We have no idea what it is.

It only interacts with the kind of material that we understand gravitationally. Light doesn't interact with it in any way. So, as I say, we can't see it.

We can only detect it gravitationally. We don't know what it is. There are all sorts of experiments, by the way, trying to figure out what it is, what kind of particle makes up this dark matter.

We don't know. We just know it is there. And as I mentioned, here is a more accurate curve of what things look like.

And there's Vera Rubin, who did the work. And as you can see, the expected distribution of velocity is this lower dotted curve. And what we actually find is the following: as we move away from the center of the galaxy, the speed actually increases.

The galaxy should fly apart. Why isn't it flying apart? Because there's more matter there than what we see. And that particular matter, that dark matter, is what's holding the galaxy together.

So we know there is dark matter in the universe. But how much? Here is where the cosmic background radiation helps us figure that out. So the conclusion is that dark matter is real.

Now, back to the CMBR. And here we are with the Atacama Cosmology Telescope that has very fine resolution of the anisotropies, if I may use that word, the difference in temperatures as you look at various positions in the sky. And what you can do is you can look at these regions and do some statistics.

How many of these regions, as we see them projected against the sky, are one degree in diameter? How many are a half degree? How many are a quarter of a degree? How many are two degrees, et cetera? And we do those statistics. And what we find, if you make a plot of the width of the various regions and how many there are at that particular width, what you find is a graph that looks like that. What does it mean? Well, what it means is most of the regions are about one degree in diameter.

Then you have a few that are half a degree, fourth degree, et cetera. Then it sort of tails off. But those first few peaks give us an enormous amount of information concerning the makeup of the universe.

And the reason is, in order to get these peaks, in order to get a graph, in order to make a prediction that follows the results that we have, the measurements that we have, what you have to throw into that mixture, into your equation, if you like, that is going to try to simulate this graph is what's the distribution of matter. How much do we think is baryonic matter? How much is dark energy? How much is dark matter? What's the geometry of the universe? That's got to be thrown into the mix. And the change of any one of those things gives you a different curve.

And you work on these things until you match the results that you actually see. And it also, what is the Hubble constant we're going to use? All these things have to come into the mix in order to get the graph that maxes the observations. And then once we get a graph that matches the observations, and we see those are the only variables that we can adjust, and there are no other variables, then we say, aha.

We know then what the makeup is of the universe that will give us this particular curve that matches our observations. You see how that goes. And that procedure, when concentrating on the Hubble constant, gave a huge problem and headache to cosmologists.

Because the Hubble constant that was measured using the normal ways that we've seen before that let us know that the universe is expanding, that number differs greatly from the number that we find with WMAP. There's a huge difference. And here's what we're saying here.

Over to the left, we have what the range is of the Hubble constant that has been measured by looking at the cosmic background radiation. And over to the right, you see various kinds of measurements. And they are giving us a Hubble constant that is really quite different from what has been measured.

And for you statisticians, this is a three-sigma difference that you have. That might not mean much to many people, but it is a huge difference. And basically, what you have, if you look at the history of measurements of the Hubble constant using a certain kind of star and using WMAP, what you find is that they are differing.

As time goes on, the measurements differed. They were getting more and more spread out. Well, that was a huge crisis.

But in the last few years, an astronomer from the University of Chicago by the name of Wendy Friedman has been using other things to measure the expansion of the universe by looking at different kinds of stars. This is what she calls the red giant branch. And the red that you see here is her results.

And it shows that it is getting close to the measurements of both. So this may not be as much of a problem as it first appeared. Let me just try this a different way, because this is an important problem in astronomy.

Here is WMAP. This is the satellite that has measured the rate of expansion. And you see the numbers there.

The rate of expansion, by the way, is in kilometers per second per megaparsec, which sounds a little bit like furlongs for Fortnite. But this is the number that is used. And then here are all the measurements that have been done using stars, using supernovas, et cetera.

And you can see there's a gap there. But now the work of Wendy Friedman is sort of bridging that gap. All to say is that you can use WMAP for the Hubble constant.

It brought up some difficulty with what we found just looking at the stars that we used in order to measure the Hubble constant. But fortunately, that is coming together. So it is still somewhat of a problem, but not a huge problem.

In fact, Bradford Benson of the University of Chicago says that cosmologists deserve some credit already, even with this difference. Despite the discrepancy, for a value calculated from such unrelated astrophysical phenomena, the numbers are astonishingly close. We're saying this is a crisis in cosmology, but you can turn that on its head, he says.

The fact that the numbers agree at a 5% level is pretty remarkable. So we do know the Hubble constant to within 5%. Well, further problems with the Big Bang.

In spite of the three pillars that it's built on, in spite of the thrice-supported Big Bang, there are two problems. One is the horizon problem, and the other is the so-called flatness problem. Let me deal with the horizon problem.

And here's where I'm going to be waving my hands. I'm sitting here on Earth, and I'm looking over in that direction. And my cosmic horizon is about 14 billion light years away.

Great, it took 14 billion years for the light from there to reach me. Now I look in the other direction, and that horizon is 14 billion light-years away. It takes 14 billion years for that light to reach me.

But the light from over there has not reached that horizon, nor has the light from that horizon reached the one over there. So what? Let's get back to the cosmic background radiation. It had this overall look of hot spots.

There were isotropies there. But it pretty much looked the same, whether you're looking in that direction or whether you're looking in that direction. What it's telling us is that the physical makeup of the universe in that direction is exactly the same as the physical makeup of the universe in that direction.

On the other hand, there's no way those two parts of the universe communicated. There was no way for those two parts of the universe to have been close enough in order for one to influence the other. This is a little hotter.

This is a little cooler. All right, we'll get together, and we'll even out the temperature. Oh, this has more matter.

This has less matter. Oh, we'll get together, and the matter will even out. Those parts were never together.

There was no way to have the information of what the temperature or the density or whatever is happening in that part of the universe to reach that part of the universe so that they all be the same. So how did they all become so regularized when they were not in communication? As I mentioned before, nothing goes faster than the speed of light. So whatever information that part of the universe has concerning its mass, concerning its temperature, concerning its distribution, there is no way it could communicate it to that part of the universe so that part of the universe follows the other part of the universe.

How do we explain that? That's the first problem. The other problem is the flatness problem. Back to our graph.

By looking at the size of the splotches, at the size of these anisotropies, what we find is the following. And this is work done by George Smoot. If the universe is flat, that is to say, I'm not talking about a tabletop here.

What I'm talking about is, in the center diagram, if the universe is flat- if Euclidean geometry is what really holds in our universe, it's not curved in any way, either negatively or positively- the size of the splotches that we see is the real size. On the other hand, if the universe is, as you see on the left, spherically shaped, then as the light comes towards us, it is bent in such a way, as you can see here with this top diagram: the light coming from this splotch bends. By the time it reaches our telescopes, and then when we look straight out and see what the projection of that splotch is on the sky, it looks bigger.

In other words, it acts like a magnifying glass. On the other hand, if you have what's known as negative curvature, which is like a saddle point, then the light bends exactly the other way. And when you look out, the splotch would seem smaller than it actually is.

But we find the splotch is exactly the size that we expect. Space is Euclidean, but so what? The measurements tell us that space is Euclidean to about a 0.4% margin, or one part in 250. That is to say, we differ at this time of the age of the universe.

We differ from Euclidean geometry by one part in 250. But what was that difference when you go back in time? Let's go back to one second after the Big Bang, when the universe was just beginning its nucleosynthesis. What was the accuracy there? What would it have to be there in terms of being flat so that by the time the universe expands to our time, it only differs by one part in 250? You can calculate that as you go back one second after the Big Bang.

The flatness had to be one part in 10 to the 15th, as you see down below here. Now, let me explain this some other way. I want to shoot a goose across the bay there, which probably some of you would be very happy to have me do.

So I want to shoot a goose across the bay, and I'm aiming my rifle. And a goose is what? Maybe two feet across or so, 2 and 1⁄2 feet. So what I have to do is aim my rifle in order to hit the goose.

If I'm five feet away, that's not a big deal. I have all sorts of variability as to how I'm going to aim my rifle. But what happens as I move farther and farther away? Now, I have less variability in how I'm going to aim the rifle.

And the farther away I get, the more I have to make sure that my rifle is exactly right so it hits the goose. So the farther away I am, the less variability I can have in the direction of my rifle. And what we're saying here is that at this point, the rifle can be accurate to one part in 250, but back one second after the creation of the universe, after the Big Bang, it had to be accurate to one part in 10 to the 15.

That's the one with 15 zeros after it. How in the world do we get that kind of accuracy? You think that's bad? Go back to about 10 to the minus 37 seconds after the Big Bang, and you'll see why I'm using that particular time. How accurate does the rifle have to be? One part in 10 to the 60th.

One part in 10 to the 60th. That's the flatness problem. How is the universe so flat? Well, as I mentioned, 10 to the minus 37 seconds after the Big Bang, that's what ABB stands for.

It would be one in 10 to the 60th. Well, how do we explain this? Well, as John Calvin used to say, that's the way the mop flops. Sorry, that's just the way it is.

It was created that way. I mean, nobody but God could really fine-tune something that well. But maybe there's a more deterministic view.

Maybe there's some scientific principle that explains this without resorting to what some people would say is the god of the gaps. Yes, there is. Inflation.

And I'm not talking about economic inflation here. I'm talking about the universe. And here's what we're talking about.

This was proposed back in the 80s by Alan Guth, who finished his undergraduate work and PhD at MIT, did quite a number of stints as a postdoc, and then wound up going back to MIT, where he has been. And he proposed a solution to these problems with an inflationary universe. By the way, that's not even what he was working on.

What he was working on is that theoretical physicists who work with particles said that the universe should be filled with what is known, a quantity known as a monopole. Magnetic monopole. In other words, just an isolated North Pole or an isolated South Pole.

Well, all of us know enough about magnets that you have a North Pole and a South Pole. And if you take a magnet and cut it in two, what happens? You still have a North Pole and a South Pole. We don't have individual poles, North Poles and South Poles.

And as one person said, what would be interesting is to call Fisher Scientific sometime and say, hey, I want to order five North Poles and three South Poles, and see what they say. Well, they should exist. And there should be quite a few of them in the universe, but they haven't been observed.

And they should be observed, because they are something like 10 of the 16 times more massive than a proton. So we should have observed these things by now. At any rate, the proposal is the following.

Overall, in some big ether, what you have are tiny little seeds. And by tiny little seeds, what I mean is maybe about 10 to the minus 24 centimeters across. I mean, we're talking really tiny.

And in that tiny seed, conditions are such that, following Einstein's general relativity, you can have gravity under certain conditions that act like a repulsive force. And it is very repulsive. And so in these seeds, and don't ask how this came about.

We don't know. But in these tiny seeds, you have a sudden repulsion that blows up that seed from the size of 10 to the minus 24 to about the size of a marble. And what you have is about 100 times in that particular period of time, which, by the way, is about 10 to the minus 37 seconds to about 10 to the minus 33 seconds.

You have 100-fold doubling of the size of the universe. And that's what takes it to a size smaller than a proton, to a size that is about that of a marble. At that point is where we begin to use the physics that we know in order to describe what's happening to the universe.

I know, it seems unbelievable, doesn't it? That we all, boy, what weight loss is that, right? You take everything, and you fit it down into a size less than a proton? I mean, talk about weight loss. Well, this right here is a diagram that explains what's happened at that particular time. And at that arrow, where you have the sudden inflation, this is really where we start using our mathematics and our observations to describe the universe as I have done up to this point.

Now, bear with me a little bit. Here's the idea behind inflation. As I mentioned, for very small regions of space, you can have gravity, which is repulsive.

It does a fantastic job of advancing and expanding the universe about 10 to the 28 times. And inflation continues until the so-called inflation field, where we don't know where it came from. To be honest about it, and Guth will say the same thing.

People will say the same thing. We don't know where it came from, but we feel it happened because it solves problems, which I will mention in a moment. The inflation field decays.

The universe, however, is starting its expansion, and it continues to expand until the present day to what we see now. Well, what does it solve? The horizon problem. You remember? The different parts of the universe are not in connection, where one part can tell the other part what its temperature and mass and all that stuff should be.

In that tiny little seed, everything was together. Everything had normalized. Everybody in that little seed agreed what the temperature and the density and all that was.

And now that expands. It expands faster than the speed of light. Therefore, one part cannot communicate with the other part now.

But what conditions were present at that time now have been spread out to a universe that cannot communicate. One part cannot communicate with the other because the parts are so far apart. So it solves the horizon problem.

It solves the flatness problem. Imagine being on a balloon that is this big, and you're an ant on that balloon. And so you go out about, let's say, five inches, and you can see it's curved.

One way you can see it's curved: you draw a triangle on there, and you find that on a sphere, you add up the three angles of a triangle, and it's greater than 180 degrees. All you have to do is just go from the North Pole to the equator, 90 degrees. Go around the equator, 90 degrees.

Go from the equator up to the North Pole, 90 degrees. And what we've got is 270 degrees. Now, suppose, however, that same ant that can only look out about five inches; now suppose that balloon blows up to the size of the Earth.

The ant is going to do everything possible. The angles are going to add up to 180 degrees. In other words, whatever the geometry is before the inflation, after the inflation, everything looks flat.

It is just so expansive, so big, everything looks flat. That solves the flatness problem. Why? Because everything started that way, back 10 to the minus 37 seconds after the Big Bang, and that is what aimed the rifles.

So we are still on that particular trajectory. It solves the variations in the cosmic background radiation. How does it do that? Forgive me if I run five minutes longer here.

How does it do that? When you start looking at space, very, very, very, very small, you have to start looking at what are known as quantum effects. And what quantum mechanics tells us is that space, no matter what the vacuum is, space is never empty. You always have slight variations in energy density, in matter density.

In fact, what you have in empty space, as a result of Heisenberg's uncertainty principle, is particles popping into existence and popping out of existence in very, very short times. If you take a look at space at very, very small scales, again, what you're going to find is there are distortions, and it's constantly changing. That's just the nature of matter.

That's just the nature of what quantum items do. And so before the little seed expands, you've got all these little variations. Now, woof, it expands.

Those variations are frozen into the universe. And those variations that were microscopic at that point now become macroscopic, and that's what we see in the cosmic microwave radiation. So the distribution is solved.

And by the way, the distribution is important, because you've got to have mass concentrations that eventually will make galaxies, and stars, and planets, and people, and what have you. So that's very important. And then it also solves the monopole problem that I mentioned before that Guth was working on.

Well, here's where inflation leads to the idea of a multiverse. Why? Woof, there it is. Because why should there only be one seed? There could be many seeds.

We don't know, because we are just a product in one of those seeds that has expanded into a universe. But there could be other seeds. If a seed can exist that gives rise to this universe, why can't seeds exist that give rise to other universes? There's nothing fundamentally wrong with that.

But here's the problem. Nobody has figured out a way to really test that. All we can say, it works for this universe.

It has to work for other universes. But nobody's really able to test that. But mathematically, philosophically, there's no big problem with that.

But if that's the case, where does it leave us? Is the multiverse provable? Yes, if you look at our universe, as I said. Interestingly enough, if anything can happen in science, it probably happens many times. If there's no physical law that prevents a certain phenomenon from happening once, there's no physical law that says it's going to happen once and only once.

And we can apply that also to the universe. If we have a seed that inflates to the size of this universe, it probably happened all over other universes. Maybe different than ours, separated from ours.

We're not going to see it unless maybe two universes crash together and we begin to see variations in the cosmic background radiation. But there's no real way that we can actually test this in the normal fashion that we think of as testing. So yes, it is reasonable, given the physics of our universe, given the principle of multiplicity.

On the other hand, we'll never be able to test it by looking at another universe. Does a multiverse preclude the work of God? No. If he can create this universe, why can't he create other universes? Maybe even with different physical laws.

There's nothing that really prevents that. But if there are so many universes, how is it that we just happen to be in one that supports life? Well, here we go again. Is it by chance? That's the way the mop flops? Or has God really designed it this way for our particular universe that expands? So you say, well, God put us here.

After all, he wanted to make human beings. He needed a universe where human beings can exist. He wanted to create a universe through a multiplicity of events.

This is the universe. Here we are. What's your problem? It's OK for a theist.

But what about a non-theist? Here we have the principle of mediocrity. And the idea is that we have all of these universes, but we happen to be in one that's mediocre. We aren't in one that is characterized by violent events and what have you.

We aren't in one that is so staid that you can't have anything form like us. So that's the principle of mediocrity. But let me just end with this.

Is there a proposal as to how many universes there might be? And here is what we're going to see. First of all, first, what is giving rise to the present expansion in dark energy? And why is the dark energy what it is at this point? I'm leading to something here. Bear with me.

Here we bring in modern theories of particle physics, trying to understand the dark energy. We sort of understand the dark matter. We know it's there.

We don't know what it is. But what about dark energy? Maybe we make a stab as to what that is. We again go to our quantum fluctuations.

We again go to our nuclear theories and particle theories that say anywhere in the universe, you can have particles that pop in and out of existence. They can be electrons. They can be protons, neutrons, photons.

And I want to stick to photons. The energy of a photon is inversely connected to its wavelength. In other words, the shorter the wavelength, the more powerful the photon is.

Well, you say, well, you can have photons of any wavelength that pop in and out of existence. You're not going to see them because the time scale is so small. Pop in and out of existence.

But every one of those has a certain amount of energy. If the energy is proportional to 1 over the wavelength, and you can have as short a wavelength as you like, what happens if the wavelength is shorter and shorter and shorter and shorter? What happens to the energy? Whoosh. It shoots up.

Well, where are you going to stop this calculation of how much energy you should have by photons popping in and out of existence? You're going to stop at the Planck length. Remember what I said. At 10 to the minus 43 seconds after the Big Bang, that's where we start.

In fact, we start about 10 to the minus 37 seconds after the Big Bang. But nothing can take us before that time of 10 to the minus 43 seconds. Well, how far does light travel? How far does light travel in that particular time? It turns out it will travel; if you take 10 to the minus 43 seconds and multiply it by 300,000 kilometers per second, it turns out that the Planck length at the Planck time is about 10 to the minus 33 meters.

So that is going to be the shortest wavelength of photons that you're going to be able to generate. When you make the calculation, it turns out with the virtual particles, virtual photons, and everything, when you calculate what the energy should be, it turns out to be

10 to the 120th times greater than what we measure. This is seen as the most embarrassing theoretical prediction that has ever been made.

Why is it that we live in a universe that has such low expansion energy, such low dark energy, when how can it be off by that much? And here is perhaps, again, the multiverses have, not all multiverses have as much dark energy. And again, we just happen to be in one that doesn't. Otherwise, we wouldn't exist.

Too much dark energy, the universe would have blown up by now. Too little dark energy, it would have collapsed by now. So we're right at that point.

And with this, I'm going to leave you with a couple more things. Suppose the dark energy density can vary from the amount we have to 10 to the 120 times more than we have. We have a whole range there.

Suppose we are looking at our dark energy amount, and we say, well, it can vary by a factor of 1,000, and still live. If it varies by more than that, if it's more than that, the universe blows up. Galaxies don't form.

If it's less than that, then the universe collapses on itself. So we have a range here of about, let's say, 1,000, a range of about 1,000. String theorists tell us that we can have something like 10 to the 500th substrates that can serve as nuclei for our multiverse.

Now, you say we can vary by about 1,000. What that means is that even if you have a range of 10 to the 120th, if you have 10 to the 500th seeds that can form universes, what it means is you can have as many as 10 to the 380 universes that can be seeds. And we just happen to be in the right one.

I'm sorry, but that's where the story ends. So our chances of being in a universe like ours is pretty good. And this is the anthropic principle, because if we were not in this kind of a universe, we wouldn't exist to be able to examine it.

So we're here. Well, this is what's interesting. By the way, a joke.

This comes from Alan Guth. You ask people, do you really believe in inflation? And the answer is yes. It's not a bad theory, by the way, OK? It's not a bad theory.

And there's a fellow who is a Strathmore Royale in England by the name of Martin Rees. And he very much believes in inflation. And somebody asked him, to what extent do you believe in inflation? He says, well, I'd be willing to bet my dog on it.

Then there's Andre Lind, who is from Stanford, who also believes in inflation. In fact, he's done a lot of work on this. And he says, I am so convinced, I am willing to bank my life on it, which is pretty serious.

Then Steven Weinberg, one of the greats of particle physics and cosmology, would ask, well, how much do you believe in inflation? He said, well, I'm willing to bet Martin Rees' dog and Andre Linde's life. So there you go. Well, another cosmologist that's very close at Tufts University, Alex Vilenkin and Dilya Purov have written a book, Cosmology for the Curious.

And here's what they say. And I'm going to end with a couple of quotes here. He goes into this description.

He says, we have described how an inflating sea could emerge from what seems to be literally nothing, a state with no space, no time, and no matter. However, the birth of the universe by quantum tunneling, which is what I was trying to describe, is described by the same laws of physics that govern its subsequent evolution. So the laws must be, quote, there prior to the universe.

And the laws of physics are definitely nothing. So OK, you don't have matter, but now the matter is supposed to follow certain physical laws. Where do physical laws come from? OK, that's a reasonable question.

The notion of, quote, nothing, and they keep putting this in quotes, transmuting into something under the spell of abstract laws of nature is deeply mystifying. We have stumbled far into the unknown. Well, Robert Jastrow, whom I brought up before, also has an interesting quote.

At this moment, it seems as though science will never be able to raise the curtain on the mystery of creation. For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance.

He is about to conquer the highest peak. As he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries. Thank you.