First Scientific Confirmation of the Second Premise

We have been looking at philosophical arguments for the second premise of the *kalam* cosmological argument, *the universe began to exist*. We now have two philosophical arguments for the second premise– one based upon the impossibility of the existence of an actually infinite number of things, and the other based upon the impossibility of forming a collection of an actually infinite number of things by successive addition (adding one member after another one at a time).

Lest we lose the forest for the trees, let's just step back a moment and ask what we've done here. What we've basically argued is that the idea of an infinite past is absurd. The past cannot be infinite, and therefore it must have a beginning. These arguments, though seemingly very complex and mind-stretching, can be shared in a very simple way. That is important to understand lest you just throw up your hands and say *all this mathematics is too difficult for me*.

The first argument based on the impossibility of an actually infinite number of things – what I often do in a debate situation is to simply say that the existence of an actually infinite number of things is impossible because of the absurdities that would result if it could exist. For example, what is infinity minus infinity? That is a simple question. You get self-contradictory answers, and that shows that infinity is just an idea in your mind, not something that exists in reality. So there can't be an actually infinite number of past events. That is a very simple statement of that first argument.

As for the second argument, you can simply give the illustration of an infinite series of dominoes and say, *How can the present* *domino ever fall if an infinite number of earlier dominoes had to fall first one after another?* You'd never get to the present domino. So we know that the past can't be infinite; it must have had a beginning – it must be finite.

There, you see I've shared those two arguments in about 45 seconds. Even though there is a wealth of interesting material below the surface, the tip of the iceberg can be shared in a relatively simple and straightforward way.

Now we want to go on to scientific confirmations of the beginning of the universe.

One of the most astonishing developments of modern astronomy and astrophysics, which our Muslim theologian al-Ghazali could never have anticipated, is that we now have pretty strong scientific evidence for the beginning of the universe. I like to think of these scientific arguments as confirmations of a conclusion already reached by philosophical argument. That is to say, given the scientific evidence, the statement "The universe began to exist" is more probable than it would have been without that evidence. Indeed, I think that the scientific evidence makes it more probable than not that the universe began to exist. So when someone says to you, as they very often do, *Nobody knows how the universe began. Nobody knows whether the universe had a beginning or is eternal,* what they are usually thinking of by the word "know" is "know with certainty." Of course, that is not what we are claiming here – that somebody knows with certainty. Science doesn't deal in certainties. What we are saying is that given the scientific evidence that we have, it is more probable than not that the universe did have a beginning. It seems to me that it is almost undeniable to say at least that the scientific evidence confirms that the universe began to exist, that that statement is more probable given the scientific evidence than it would have been without it – than it was, say, in the early 20th century before the Big Bang model was ever broached or the expansion of the universe discovered. The evidence at least confirms the second premise, even if it doesn't render it certain. Certainty is a will-o'-the-wisp that we don't need to be concerned about. The question is: is the premise more probable than not given the evidence that we have? I think that it is.

Let's look at the first scientific confirmation, which comes from the expansion of the universe.

All throughout history men have assumed that the universe as a whole was eternal and unchanging. Of course, things in the universe were transitory and changing, but the universe as a whole was just there, so to speak. This was also Albert Einstein's assumption when he first began work on his General Theory of Relativity.

In 1917 Einstein applied his gravitational theory, which is called the General Theory of Relativity, to the universe as a whole. The theory is really not a theory of relativity. It is a theory of gravitation. It is the theory of gravitation that is accepted in physics today. In 1917 Einstein began to apply his newly discovered gravitational theory to the universe as a whole.

But he found that something was terribly amiss. His equations described a universe which was either blowing up like a balloon or else collapsing in upon itself. During the 1920s the Russian mathematician Alexander Friedman and the Belgian astronomer

Georges LeMaître independently discovered models of the universe which took Einstein's equations at face value, and as a result they enunciated models of an expanding universe. In 1929 the American astronomer Edwin Hubble, through tireless observations at Mt. Wilson Observatory, confirmed Friedman and LeMaître's theory. He found that the light coming to us from distant galaxies appears to be redder than expected. This "red shift" in the light was most plausibly explained because the galaxies are moving away from us and therefore the light waves are stretched, so that they appear to be redder than expected. Wherever Hubble trained his telescope in the night sky, he observed this same redshift in the light from the galaxies. It appeared that we are at the center of a cosmic explosion, and all of the other galaxies are flying away from us at tremendous speeds!

Now according to the Friedman-LeMaître model, we are not really at the center of the universe. Rather an observer in any galaxy will look out and see the other galaxies flying away from him. This is because, according to the theory, it is really space itself which is expanding. The galaxies are actually at rest with respect to space, but they recede from each other as space itself expands. The best way to visualize this, I think, is to imagine a balloon with buttons glued on the surface. The buttons are glued in place so they cannot move across the surface of the balloon. The buttons are stuck in place. But as you blow up the balloon, the buttons will get further and further apart because the balloon itself is inflating. Those buttons are just like the galaxies in outer space. The galaxies are actually at rest with respect to expanding space, but they recede from one another as space itself expands.

The Friedman-LeMaître model eventually came to be known as the Big Bang theory. But that name can be misleading. The Big Bang sounds like an explosion, doesn't it? But thinking of the expansion of the universe as a sort of explosion could mislead us into thinking that the galaxies are moving out into a pre-existing empty space from a central point. That would be a complete misunderstanding of the theory. As we've seen, the theory is much more radical than that. It is space itself which is expanding.

As you trace this expansion back in time, the galaxies will get closer and closer together. Eventually the distance between any two points in space becomes zero. You can't get any closer than that! So at that point you have reached the boundary of space and time. Space and time cannot be extended any further back than that. It is literally the beginning of the universe.

To imagine this, we can think of our three-dimensional space as a two-dimensional disk. We can represent the expansion of space geometrically as a cone. The vertical dimension represents time. Over time the universe is expanding. As you go back in time, space shrinks down until the distance between any two points in space becomes zero. That is the beginning of the universe. What is interesting about a cone is that although it can be extended indefinitely in one direction, it has a boundary point in the other direction and cannot be extended in that direction. Because this direction represents time and the boundary point lies in the past, that point represents the beginning of the universe. It implies that the past is finite and that therefore time and the universe began to exist.

Since space-time is the arena in which all matter and energy exist, the beginning of space-time is the beginning of all the matter and energy in the universe. It is the beginning of the universe itself.

Notice that there's simply nothing prior to the initial boundary point. There's nothing prior to the beginning of the universe. Here it is very important that we not be misled by words. When scientists say, "There is nothing prior to the initial boundary," they do not mean that there is some something prior to it, and that is a state of nothingness. That would be to treat nothing as though it were something! Remember when we talked about what "nothing" means. It is just a term of universal negation meaning "not anything." So when they say there is nothing prior to the Big Bang or nothing prior to the boundary point, what they mean is there was not anything prior to the boundary point. At that boundary point, it is false that there is something prior to this point.

Incredibly, the standard Big Bang model thus predicts an absolute beginning of the universe. If this model is correct, then we have amazing scientific confirmation of the second premise of the *kalam* cosmological argument – the universe began to exist.

The question then is: is the standard model correct? Or, I think, more importantly, is it correct in predicting a beginning of the universe? Despite the empirical confirmation from the redshift, microwave background radiation, and other evidence, the standard model will need to be modified in various ways. The model is based, as I've mentioned, on Einstein's gravitational theory – the General Theory of Relativity. But the General Theory of Relativity breaks down when the universe is shrunk down to sub-atomic proportions. At that point, you've got to introduce quantum physics in order to describe the earliest split-second of the universe. You need a theory that would combine General Relativity (or gravity) with quantum physics to have a quantum theory of gravity to describe the first split-second of the universe. The problem is, nobody knows how to do this yet – the theory doesn't exist. Moreover, the expansion of the universe is probably not constant as it is in the standard model. It's probably accelerating. The universe is actually speeding up in its expansion and may have had a brief period of super-rapid (or inflationary) expansion very early on in the history of the universe. So the standard model is going to need to be modified in various ways if it is to be empirically adequate.

But none of these adjustments need affect the fundamental prediction of the model that the universe had an absolute beginning. Indeed, over the decades since Friedman and LeMaître physicists have proposed scores of alternative models in order to avoid the absolute beginning of the universe. And those models that do not feature an absolute beginning have been repeatedly shown to be untenable. To put it more positively, the only viable non-standard models are those that involve an absolute beginning to the universe. That beginning may or may not involve a beginning point. But even those that do not have a point-like beginning are still finite in the past. The past is not infinite, but finite. On these models (like Stephen Hawking's so-called "no boundary" proposal) the universe has not existed forever. Rather, it came into existence even if it didn't do so at a sharply defined point.

In one sense, the history of twentieth century cosmology can be seen as a parade of one failed attempt after another to avoid the absolute beginning predicted by the standard model. That prediction has now stood for over 100 years through a period of enormous advances in observational astronomy and creative theoretical work in astrophysics.

With that I will bring it to a close today. Next week we will continue to discuss the significance of more recently discovered singularity theorems that also imply that the universe began to exist.