Modern Physics, the Beginning, and Creation

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Beginning and Creation

Some religious people look upon the discovery of the Big Bang as a scientific proof that the universe was created by God. Some atheists, on the other hand, point to speculative physics theories in which the universe had no beginning as showing that no Creator is needed. Both of these views are wrong and for the same reason. Both mistakenly equate the idea that the universe was created with the idea that the universe had a beginning some finite time ago. Admittedly, the Book of Genesis itself links creation and beginning when it says, "In the Beginning, God created the heavens and the earth." But even though the two ideas are connected, they are not the same. No less a theologian than St. Thomas Aquinas understood this very well. He believed it possible to prove philosophically that the universe is created, but not possible to prove philosophically that the universe had a beginning rather than having existed for infinite time.

At first, this sounds strange. Isn't it obvious that if something was created, it must have been created a finite time ago? That's certainly true of things that are "created" by human beings. If an artist paints a picture, that picture can be dated to the time when the artist painted it. Because the picture was made, it had a beginning. But the Church tells us that God does not create in the same way that human beings "create"; the comparison between the two is merely an analogy, and in this case somewhat misleading. So let us use a different analogy. Imagine a piece of paper that has

been illuminated by a lamp forever, i.e. for time stretching infinitely into the past. Even though the illumination of the paper has always had a cause --- namely the lamp --- the illumination of the paper had no beginning. In a similar way, the existence of the universe must have a cause --- namely God --- but that does not necessarily imply that the existence of the universe had a beginning.

Creation has to do with why something exists at all, not with how long it has existed. One may put it another way: there is a difference between the *beginning* of a thing and the *origin* of a thing. The beginning of the play *Hamlet* is a set of words in Act I, Scene 1, whereas the origin of the play *Hamlet* is the creative mind of William Shakespeare. Shakespeare is the origin of the play in the sense that he is the reason that there is a play at all; he is the cause of its existence as a work of art. Similarly, the beginning of the universe is merely the set of events that happened in its first moments (about 14 billion years ago, according to present calculations), whereas the origin of the universe is the mind of God. Just as it would be silly to answer the question of why there is a work of art called *Hamlet* by pointing to its opening words, it would be silly to answer the question of why there is a universe by pointing to its opening events. Indeed, the opening of a play or the opening of the universe really have nothing to do with the cause of their existence. One could imagine a play that has no beginning or end --- for example, a play whose plot goes round in a circle --- and it would still require an author. Likewise, one could imagine a universe without beginning or end, and it would still require a Creator.

Now, even though the creation of the universe does not in itself imply that it had a temporal beginning, and even though, according to St. Thomas, God could have created a universe that had no beginning had he willed, the Book of Genesis tells us that our world did in fact have a Beginning, and both the Fourth Lateran Council and the First Vatican Council spoke of God creating the universe "from the beginning of time".

Creation and Time

This brings us to a key point that was first understood by St. Augustine sixteen hundred years ago and only rediscovered by modern physics in the twentieth century. This point is that *the beginning of the universe was also the beginning of time itself.* In antiquity, many pagans mocked the Jewish and Christian teaching that the universe had begun a finite time ago, and they asked Jews and Christians what their God had been doing for all that infinite stretch of time before he got around to making the world. St. Augustine had a profound answer. He started with the idea that time, being a feature of this changing world, is also something created. Therefore, if time is passing, something created --- namely, time itself --- already exists, and hence creation has already happened. Consequently, it makes no sense to speak about any time passing "before creation". Time itself, as a created thing, began with the beginning of created things. God was not waiting around for infinite time before he created the world, said St. Augustine, for there is no such thing as "a time before creation." As he put it in Book XI of his *Confessions*, "Why do they ask what God was doing 'then' [before creation]? There was no 'then' where there was no time."

Modern physics has reached the same conclusion by a parallel route. Whereas St. Augustine started with the insight that time is something created, modern physics starts with the insight that time is something physical. After Einstein's theory of General Relativity, it became clear that space and time, rather than being something over and above physical events and processes, actually form a physical "space-time manifold" or fabric that is acted upon by other physical entities and acts upon them in turn. Space-time can bend and flex and ripple; and these distortions of space-time carry energy and momentum, just as all physical things do. Indeed, space-time is just as physical as magnetic fields are, or as rocks and trees. It follows therefore, that if the physical universe had a beginning (say, at the Big Bang), then space-time, as features of the physical universe, also began at that point. Before the beginning of the universe, therefore, there was neither time nor space; so that it in fact makes no sense from the viewpoint of modern physics to even use the phrase "before the beginning of the universe." Modern physics has vindicated St. Augustine's profound insight.

It is hard, indeed impossible, for the human mind to imagine time having a beginning. We must therefore again resort to analogies. Let us return to the analogy of a play. The plot of a play has a timeline in which its events can be located. If the play is in book form, we can locate its events by the page and line in which they occur. But the timeline of a book or play only applies to events within that book or play. It makes no sense, for example, to ask where in the timeline of the play *Hamlet* --- on which page --- the wizard Gandalf fights the Balrog or Sherlock Holmes meets Dr. Watson. Nor can one ask what happens in *Hamlet* after Act 5,

since the play has only five Acts, and its internal time or plot-time simply ceases at the last word that appears at the end of Act 5, scene 2. Admittedly, one can, in a certain sense, ask what happens before Act 1 of *Hamlet*, because characters in the play recall and refer to prior events --- for example the murder of Hamlet's father by Claudius. But strictly speaking, the plot-time *of the play*, measured by page and line, begins with the first line and ends with the last.

In a similar way, in the standard Big Bang theory there is a point (call it $t = 0$) that is the beginning of all physical phenomena, including space and time. As one (mentally) goes back in time toward that "initial singularity", space shrinks faster and faster, until at $t = 0$ it shrinks to nothing. Space and time wink out --- or, looking at time in the right direction, they wink *into* existence at that point. In the standard Big Bang theory there are two possible fates for the physical universe: either it will expand forever, growing ever emptier and colder, or it will reach a maximum size and starts to collapse toward what is called the "Big Crunch". (Presently, the evidence favors the former possibility.) If the universe were to end in a Big Crunch, it would mean that space and time wink out at that point, a finite time in the future. That would be "finis" to the universe, and time would stop.

To push the analogy further, we see that the internal time of a play does not even apply to the doings of the play's author. Shakespeare getting married in not an event in *Hamlet* and has no location in *Hamlet*-time. In fact, Shakespeare thinking of ideas for the plot, or inventing characters, or composing soliloquys for *Hamlet* are also not events within the play and have no location in

Hamlet-time (though they are, of course, the reason why certain things happen when and as they do in the play). Shakespeare is outside of his play and outside of its time. In an analogous way, the traditional Catholic teaching is that the space and time of this universe simply do not apply to God himself, in his divine nature.

Suppose, for example, we think of two physical events *A* and *B* that happen in our universe. Event *A* may come before *B* in physical time, and may perhaps be the cause of *B*, or at least influence *B*. God wills that *A* happen and that *B* happen, and he wills that the *occurring of A* come before the *occurring of B* in space-time. But God's *willing of A* does not happen before his *willing of B*. God's willing is not a physical process and therefore (unlike *A* and *B*) is not an event in space-time. The *effects* of his willing (namely, the events *A* and *B* themselves) do have a location in space and time, but that is not the same thing.

God's causing of *A* and *B* is on a different level altogether than *A*'s causing of *B*. Once again, the analogy of the play makes this clear. One may ask: Did Polonius die because the character Hamlet stabbed him? Or did Polonius die because Shakespeare wrote the play that way? The correct answer, of course, is "both". Hamlet stabbing Polonius is the cause *within the play* of Polonius dying. But Shakespeare is the cause of the whole thing --- of the existence of the play *Hamlet*, of all its characters, all its events, and all the relationships among the characters and events, including where they occur within the play and how they fit into the causal structure of its plot. In an analogous way, physical events in this universe have spatio-temporal and causal relationships to each other, but the whole universe and all its events and internal relationships only exist because God conceived of them and willed that they should

exist and have these relationships to each other. This is the classical distinction between primary and secondary causality. The causes *within* nature are called "secondary causes", whereas God (the "primary cause") is the cause *of* nature.

This raises the question of whether the beginning of the universe, which may have been the "Big Bang", was a "natural event". There is no reason coming from physics to doubt that it was. To say that an event is natural, is to say that it happens in accordance with the laws of nature. It is true that in the classical Big Bang theory the point $t = 0$ is a singular point at which the laws of physics break down, because various physical quantities would be infinite at that point (such as the density of energy and the Riemannian curvature of space-time). But it is known that the classical Big Bang theory cannot be a good description of nature very close to $t = 0$, because quantum mechanical effects should be important there, and present theories are inadequate to describe quantum effects at such high densities and curvatures. It is expected by most physicists that when (and if) the correct theory of "quantum gravity" is known, and the methods needed to apply it to the beginning of the universe are mastered, the singularity at $t = 0$ will melt away, and the laws of physics will be seen to apply at the beginning of the universe just as they do at later times. Nor is this merely a matter of philosophical prejudice. Long experience has taught physicists that when infinite quantities appear in their theories it is always because they have made unrealistic "idealizations."

That the Big Bang was very likely a "natural event", in the sense of obeying the laws of physics, is not a theological problem. It is like saying that the first sentences of *Hamlet* obey the laws of English

grammar just as do all the other sentences in the play. One would expect nothing else. It is only a problem if one falls into crude anthropomorphism and imagines creation to be a physical process, like God setting a lighted match to a fuse. But that is not the Christian conception of Creation. Creation is the act by which God gives reality to the universe, and makes it not merely a hypothetical or possible universe, but an actually existing universe. He does not supply energy, as a match does to an explosive, he supplies reality. God supplies this reality equally to every part of the universe --- all events at all times and places --- just as Shakespeare equally brought forth every word of the play *Hamlet*.

Was the Big Bang the Beginning of Time?

Even though the universe being created and the universe having a beginning are two logically distinct ideas, it is a fact that some atheists are discomfited by the idea of a cosmic beginning. For, even though a Beginning does not logically imply creation, it somehow suggests it. This led many in the scientific world to be prejudiced against the Big Bang theory and probably discouraged research on it and delayed its acceptance, as has been admitted by more than one prominent scientist. The Big Bang theory came out of the work of the Russian mathematician Alexander Friedmann and the Belgian physicist (and Catholic priest) George Lemaître in the 1920s. And clear evidence that galaxies are flying apart as from some vast primordial explosion was announced in 1929. Yet even as late as 1959 a survey showed that most American astronomers and physicists still believed the universe to be of infinite age. Nevertheless, evidence in favor of the Big Bang theory accumulated, and became so strong by the 1980's that it was accepted by virtually all scientists. That the Big Bang theory is

correct, however, does not necessarily settle the question of whether the universe had a beginning. There remains the possibility that the explosion that occurred 14 billion years ago was only the beginning of a certain part of the universe or a certain phase in its history, rather than the beginning of the universe as a whole. In fact, over the years many scenarios and theories of this type have been proposed. I will briefly discuss three of them, the bouncing universe, the cyclic "ekpyrotic" universe, and "eternal inflation".

I mentioned that in the standard Big Bang theory, the universe has two possible fates; it may expand forever or it may reach a maximum size and collapse toward a Big Crunch. If it does the latter, one may imagine that instead of the universe winking out at the Big Crunch, as usually assumed, it "bounces" and begins to expand again. If this were to happen, the Big Crunch would be the Big Bang of a new cycle of the universe. One can further imagine that such cycles of expansion, contraction, bounce and new expansion have been going on forever and will continue forever in the future. This scenario was proposed by Einstein himself in 1930. Can it be true? Almost certainly not, for several reasons. In the first place, it was shown many decades ago by the theoretical physicist Richard C. Tolman that in such a bouncing universe the cycles grow longer and longer (because of the increase of entropy). This means that they were shorter and shorter the farther one looks back into the past, and in such a way that the total duration of all past cycles added together was finite. That is, even in the bouncing universe scenario the universe had a beginning. Second, the entropy of the universe increases with each cycle, and from the amount entropy that exists in the present cycle one can conclude that the number of past cycles was finite. Third, it is highly

doubtful that a collapsing universe would bounce rather than simply ending in a Crunch. And fourth, it was discovered in 1998 that the expansion of the universe is currently speeding up (the scientists who discovered this were awarded the Nobel Prize in physics for 2011), so that it is doubtful that the expansion will reverse and lead to a collapse at all.

An interesting attempt to revive the idea of a cyclic universe was made about ten years ago by Paul Steinhardt and Neil Turok. In their scenario (called the "ekpyrotic universe"), there are two parallel universes, each having three space dimensions, which move toward each other through a fourth space dimension, collide, bounce, move apart, reach a maximum separation and then move toward each other again, repeating the cycle endlessly. This idea evades several of the problems of the original bouncing universe scenario. In the first place, the three-dimensional space of each parallel universe is always expanding, and the oscillations of contraction and expansion occur only in the fourth space direction (which we cannot experience or directly observe). This allows the scenario to be consistent with the fact that the expansion of our three space dimensions is accelerating and may never reverse. Second, the fact that entropy always increases with time is counterbalanced by the fact that the volume of three-dimensional space is also always increasing. Thus the entropy may always be increasing, whereas the *density* of entropy (i.e. entropy per volume) can be the same in every cycle, and the cycles can all have the same duration. Clever as the ekpyrotic idea is, however, it has been subjected to strong criticism as creating more theoretical problems than it solves. And even if it turns out to be viable as a theory of our universe, there is a powerful theorem proved by the physicists Borde, Guth, and Vilenkin, which implies the

oscillations of such an ekpyrotic universe cannot have been going on for infinite past time. There had to be a first cycle.

Another attempt to construct a realistic theory of a universe without a beginning uses the idea of "eternal inflation" developed by Andrei Linde. The idea is that the universe as a whole is perpetually undergoing an "exponential" expansion. (What this basically means is that there is a time scale *T*, such that whenever a time *T* passes the universe doubles in size.) Such an exponential expansion is called "inflation". Within this perpetually inflating universe, however, bubbles are continually forming within which space expands in the much slower fashion that characterizes the part of the universe that we can see --- i.e. the part of the universe within our "horizon". (We have a horizon since we can only see light that was emitted after the Big Bang, and such light cannot have travelled a distance greater than about 14 billion light-years.) In other words, we are inside one of these bubbles, and it is so vast that it extends far beyond our horizon. In this scenario, the Big Bang that happened 14 billion years ago was not the beginning of the whole universe, but merely the formation of our bubble.

It should be noted that the idea of inflation was not proposed whimsically or arbitrarily, but because it resolves certain very difficult theoretical puzzles in cosmology. Most cosmologists therefore believe that our part of the universe did undergo inflation at some point in the past. And it has been shown that in a wide class of theories, if some region of the universe starts to inflate, inflation tends to take over and lead to eternal inflation. However, almost all theorists agree that "eternal inflation", while it may be "eternal into the future", probably cannot be "eternal into the past".

One reason for this conclusion is the theorem of Borde, Guth, and Vilenkin referred to previously.

It seems impossible that we shall ever be able to determine by direct observation whether the universe had a beginning. We cannot see what happened before the Big Bang (if there was a "before"), because the Big Bang would have effaced any evidence of it. And even we could, how could we ever tell by observation whether the past is infinite, since any *particular* past event that we observe must have occurred a finite time ago? Nevertheless, as we have seen, there are very strong *theoretical* grounds for saying that that the universe most probably had a temporal beginning.

This is a remarkable vindication of religious ideas. The pagan philosophers of antiquity, including Plato and Aristotle, believed that the universe had always existed. The idea of a beginning of the universe and of time itself entered Western thought from biblical revelation and from the profound reflection upon it of theologians such as St. Augustine. Until the twentieth century, however, modern science pointed the other way. The idea of a beginning of time seemed to make no scientific sense, and there seemed to be definite evidence that matter, energy, space and time had always existed and always would. For example, physicists discovered the law of conservation of energy, which says that "energy can neither be created nor destroyed." In chemistry it was found by that the quantity of matter does not change in chemical reactions. In Newtonian physics, the time coordinate, like the space coordinates, extends from $-\infty$ to $+\infty$. By the beginning of the twentieth century, many scientists looked upon the idea of a beginning of the universe as a relic of outmoded religious or mythological conceptions of the world. One finds, for example, the

Nobel Prize winning chemist Svante Arrhenius saying in 1911, "The opinion that something can come from nothing is at variance with the present-day state of science, according to which matter is immutable." And the eminent physicist Walter Nernst (also a Nobel laureate) confidently declared that "to deny the infinite duration of time would be to betray the very foundations of science." When science did begin to see (from Einstein's theory of General Relativity) how time and space could have a beginning, and astronomical observations began to suggest that this might be true, many atheists had a hard time accepting it. And yet, despite all the doubts and misgivings of scientists, it seems to be the case after all that the universe had a beginning.

Faced with this fact, some atheists now pin their hopes on the idea that physics will "explain" this beginning. They believe that if the beginning of the universe can be shown to be natural, then the need for a supernatural cause of the universe would be avoided. We have already seen the mistake involved in such thinking. The beginning of the universe unfolding in accordance with natural laws no more renders a Creator unnecessary than the opening passages of a book unfolding in accordance with the laws of grammar renders an author unnecessary. Nevertheless, scientific theories of the beginning of the universe are interesting in their own right, even if they cannot bear the weight that atheists want to place on them.

Quantum Creation of Universes

The most promising approach to "explaining" the beginning of the universe physically is a speculative idea called "quantum creation of universes". This idea is based on an analogy with the unquestionably real effect called the quantum creation of particles.

This effect sounds mysterious and profound (and perhaps it is), but it is a fact of everyday life, familiar to all of us. Every time you walk into a dark room and flip on the light switch, you cause a flood of particles to be “created”, namely particles of light (called “photons”). Other kinds of particles, even the massy kind that make up what we think of as ordinary matter, such as electrons or protons, can be created, though they have to be created in conjunction with “anti-particles”. For example, an electron can be created along with an anti-electron (called a “positron”), and a proton can be created along with an anti-proton. Such “pair creation” can happen in several ways. For example, in an intense electric field, an electron-positron pair can suddenly appear out of the “vacuum”, by what is called a “quantum fluctuation” or “quantum tunneling”. Pair creation is a well-understood effect, which has been observed countless times in the laboratory, and the probability of its happening in various circumstances can be calculated precisely using the mathematical machinery of “quantum field theory”.

When an electron-positron pair is “created”, it isn’t produced out of nothing. The electron-positron pair has energy (including the mc^2 each particle has from its mass). Since energy is “conserved”, that energy must have come from somewhere. For example, when pair creation occurs in an intense electric field, what happens is that some of the energy stored in the electric field is converted into the energy associated with the masses of the electron and positron. One starts with an electric field and ends up with an electron, a positron and a somewhat weaker electric field. This “creation” is really just a transition of matter and energy from one form to another.

In quantum field theory, particles are “excitations” (or, if you will, disturbances) of “fields”. So, for example, there is an “electron field” that extends throughout all of space and time. When that field is disturbed, waves develop in it, just as when a pond is disturbed ripples are produced. Quantum mechanics says that waves and particles are two different ways of looking at the same thing. So producing ripples in the electron field is equivalent to producing electron particles (and anti-particles). We can push the pond analogy further. A pond that is still and a pond that has ripples in it are the same physical system in different states of agitation. In the same way, a situation in which there are no electrons or positrons, and a situation where there is an electron-positron pair (or several electron-positron pairs) are really just different states of agitation of the same system, namely the electron field.

Actually, one should not think of the electron field in isolation. It is merely part of a greater system that encompasses many other kinds of fields, including electromagnetic fields, neutrino fields, gravitational fields, quark fields, and so on. When an intense electric field results in electron-positron pair creation, what is happening is that a disturbance of the electromagnetic field is causing a disturbance of the electron field. This is similar to the way that a disturbance of the air (a breeze) might produce a disturbance of the water in a pond (ripples). In other words, the greater system, encompassing all the different kinds of fields that interact with each other, is making a transition from one of its many possible states, to another.

In physics, one always considers some definite “system”, which has various possible “states”, and is governed by dynamical laws

(which depend on the nature of the specific system) and by the overarching principles of quantum mechanics (which apply to all systems). The dynamical laws and the principles of quantum mechanics allow one to calculate the probabilities of the system making a transition from one of its states to another. The system might comprise only electrons, positrons, and electromagnetic fields (in which case the dynamical laws are called "quantum electrodynamics"). Or the system could be a simple pendulum, or a hydrogen atom, or the whole universe.

The idea of the quantum creation of universes pushes the mathematics of quantum theory to its logical limit --- and maybe even beyond it. Here one contemplates not merely a pair of particles suddenly appearing "in empty space" by a quantum fluctuation or quantum tunneling, but an entire universe --- along with its space --- appearing in this way. By "universe", in this context, is not meant the "totality of things", but rather a space-time manifold in which there exist fields that interact with each other. Our universe, for example, has one time dimension and at least three space dimensions (there may be more), and many kinds of fields, including electron fields, neutrino fields, quark fields, electromagnetic fields, gravitational fields, and so on. There could be other universes of the same kind. The idea is that one can go (by a quantum fluctuation) from a situation in which there are no universes, to a situation in which there is one universe; or more generally, from a situation with some number of universes to a situation with a different number of universes.

Several apparent difficulties with this idea immediately present themselves. The first of these is that the transition from no universes to one universe would at first sight seem to violate the

conservation of energy. Presumably zero universes have zero energy, whereas one universe has a lot of energy, due to all the matter that is contained in it. It turns out, however, that a "closed universe" (one whose space closes in on itself, the way a circle closes in on itself) has zero total energy: the positive energy of the matter is canceled out by the negative gravitational energy. Thus, changing the number of such universes does not violate energy conservation.

A second apparent difficulty has to do with time. In a conventional calculation using the principles of quantum physics, one considers a system making a transition from one "state" at an earlier time (e.g. an intense electric field) to a different "state" at a later time (e.g. a weaker electric field plus an electron-positron pair). However, if we talk about a transition from a "zero-universe state" to a "one-universe state", in what sense is the zero-universe state "earlier"? Indeed, *at what time* was there such a state? We have already seen that time (at least as physicists understand it) is a feature of a universe: if there is no universe, there is no time. If we look at a universe that was produced by a quantum fluctuation, we can talk about time *within* that universe, and even about the beginning of that time, but not about a time "before the universe".

We have to be careful in discussing such scenarios of falling into the verbal trap of saying that "first" there was nothing and "then" there was something. In fact, the same sloppy way of speaking is sometimes found in theological discussions of "creation *ex nihilo*." When the Church teaches that God created the universe *ex nihilo*, she is not saying that there was once a time when there was no created thing (a contradiction in terms, as St. Augustine pointed out). Rather, she is saying that there was no time when there was a

created thing that preceded the universe and out of which the universe was made. In fact, the meaning of *ex nihilo* is deeper. It is saying not only was the universe not temporally *preceded* by anything, but also that its creation *presupposes* nothing other than the will of God.

If that is what creation *ex nihilo* means, do quantum creation scenarios yield a physical mechanism of "creation ex nihilo", as some seem to believe? One can restate the question in this way: do quantum creation scenarios presuppose "nothing" in explaining the origin of the universe? They certainly talk about a "state" with no universes. But a state with no universes is not nothing; it is a definite something --- a "state". And that state is just one among many states of a complex physical system. That system has states with different numbers of universes. And all of those states are related to each other by precise rules: the dynamical laws and the principles of quantum mechanics that govern the system.

An analogy may be of help here. There is a difference between my having a bank account with zero dollars in it, and my having no bank account at all. As far as my finances go, they may both be said to be "nothing" or 'no money"; but there is a big difference. A bank account, even one with zero dollars in it, is something. It presupposes that there is a bank and that I have some contract with that bank. Those facts presuppose, in turn, that a monetary system and a legal system are in place. My bank account is thus a small subsystem of a much larger and more complex system that is governed by precise rules. My account has various "states"; a state with zero dollars, states with a positive numbers of dollars, and even states with negative numbers of dollars (if my account is overdrawn). Transitions are not made between those states willy

nilly, but in ways governed by the rules of the bank. For example, if the balance is negative and goes below some threshold, a rule may prevent further withdrawals and transitions to states with more negative balances. A state with a positive balance may periodically make a transition to a state with lower balance, due to service charges. Moreover, the rules may only allow transitions between states containing money of a certain type: dollars, say, rather than rubles, pesos, or Euros. Moreover, I can have several bank accounts with zero balances, perhaps an account in an American bank with zero dollars and an account in a Russian bank with zero rubles. They are different and distinguishable accounts, which obviously shows that each of them is something, rather than nothing.

In the same way, even to talk about a "state with zero universes" presupposes a great deal, as we have seen, namely a rule-governed system with many possible states. In any quantum creation scenario, the rules governing the system allow the "zero universe state" to make transitions to states with one or more universes, but only if those universes have precise characteristics, such as a certain number of space dimensions and certain kinds of fields --- just as the rule of my bank may only allow my account to make transitions to states with dollars rather than rubles. I can imagine many different rule-governed systems. In system *A*, the rules may only allow states whose universes have three space dimensions, whereas in system *B* the rules may only allow states with universe having ten space dimensions. The "zero-universe state" of system *A* is not the same entity as the "zero-universe state" of system *B*: they are subject to different rules that give them different potentialities.

So system *A* is one where three-dimensional universes come into and out of existence, and system *B* is one where ten-dimensional universes come into and out of existence. At this point one may ask which, if either of these systems is *real* as opposed to hypothetical. Are there *actually* three-dimensional universes coming into and out of existence, so that the mathematical laws of system *A* are governing real events? Are there *actually* ten-dimensional universes coming into and out of existence, so that the mathematical laws of system *B* are governing real events? Maybe one or the other is true, or maybe neither, or maybe both. Suppose system *A* is real, whereas system *B* is merely hypothetical. What made system *A* real, but not system *B*? *That* is the question of "creation" in the theological sense of the word: what confers *reality* on system *A* but not system *B*? And *that* is a question that the mathematical rules of system *A* and system *B* cannot possibly answer.

In his 1988 bestseller *A Brief History of Time*, the physicist Stephen Hawking correctly noted that a theory of physics is "just a set of rules and equations", and then went on to ask, "What is it that breathes fire into the equations and makes a universe for them to describe? The usual approach of science of constructing a mathematical model cannot answer the question of why there should be a universe for the model to describe." Strangely enough, it seems that Hawking forgot this key insight by the time he co-authored the book *The Grand Design* in 2010. He now thinks that a mathematical model can answer the question of why there should be a universe for the model to describe. The absurdity of that, which was not lost on the younger Hawking, can be made clear by a simple analogy. A story may be a work of fiction or of history; it may describe actual events or not. A story may tell of Stephen

Hawking being born in 1942 and going on to become an acclaimed physicist. Another story may tell of Stephen Hawking being born in 1842 and becoming Prime Minister of the United Kingdom. Can I determine just by studying the words of the two stories which one describes a real state of affairs? Do the mere *words* of either story have in themselves the power to make real the events they describe? Does the mere fact that the second story purports to tells of something (i.e. Hawking, the future Prime Minister) coming into being in 1842 mean that the thing described *actually* did come into being? Obviously not. And neither does a mathematical model purporting to describing a universe coming into being by a quantum fluctuation mean that any such thing actually happens.

In sum, the theoretical ideas by which physicists hope one day to describe the beginning of the universe, while being very interesting, and possibly correct, are not alternatives to the Creator in whom Jews and Christians believe. That Creator is not a physical mechanism or phenomenon. He is the giver of reality.