Creation *ex nihilo*: Theology and Science

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SUMMARY

The biblical doctrine of temporal creation *ex nihilo* has received strong scientific confirmation from post-relativistic physics. Two lines of evidence point to an absolute beginning of the universe: the expansion of the universe and the thermodynamics of the universe. In each case attempts to maintain a past-eternal universe have become increasingly difficult to defend.

Given the beginning of the universe, the question arises as to how the universe could have come into being. Attempts by some physicists to maintain that physics can explain the origin of the universe from nothing either trade on an equivocal use of the term "nothing" or else are guilty of philosophical *faux pas*. Supernatural creation *ex nihilo* is the better explanation.

CREATION *EX NIHILO*: THEOLOGY AND SCIENCE

Introduction

"In the beginning God created the heavens and the earth" (Gen. 1.1). With majestic simplicity the author of the opening chapter of Genesis thus differentiated his viewpoint, not only from the ancient creation myths of Israel's neighbors, but also effectively from pantheism, such as is found in religions like Vedanta Hinduism and Taoism, from panentheism, whether of classical neo-Platonist vintage or twentieth-century process theology, and from polytheism, ranging from ancient paganism to contemporary Mormonism. The biblical writers give us to understand that the universe had a temporal origin and thus imply *creatio ex nihilo* in the temporal sense that God brought the universe into being without a material cause at some point in the finite past. [1]

Moreover, the Church Fathers, though heavily influenced by Greek thought, dug in their heels concerning the doctrine of creation, sturdily insisting on the temporal creation of the universe *ex nihilo* in opposition to the prevailing Hellenistic doctrine of the eternity of matter. [2] A tradition of robust argumentation against the past eternity of the world and in favor of *creatio ex nihilo*, issuing from the Alexandrian Christian theologian John Philoponus (d. 580?), continued for centuries in Islamic, Jewish, and Christian thought. [3] In 1215 the Catholic church promulgated temporal *creatio ex nihilo* as official church doctrine at the Fourth Lateran Council, declaring God to be "Creator of all things, visible and invisible, . . . who, by His almighty power, from the beginning of time has created both orders in the same way out of nothing." [4] This remarkable declaration not only affirms that God created everything apart from Himself without recourse to any material cause, but even that time itself had a beginning. The doctrine of creation is thus inherently bound up with temporal considerations and entails that God brought the universe into being at some point in the past without any antecedent or contemporaneous material cause.

Contemporary Cosmology and Creation ex nihilo

In this paper we leave aside the fascinating philosophical questions raised by the doctrine of creation *ex nihilo*, which I have sought to address elsewhere [5], in order to focus upon the relevance of contemporary science, in particular, astrophysics and, still more specifically, physical cosmogony, to creation *ex nihilo*. Two independent but closely interrelated lines of physical evidence are relevant to the doctrine of creation *ex nihilo*: *evidence from the expansion of the universe* and *evidence from the thermodynamics of the universe*.

The Expansion of the Universe

Pre-Relativistic Physics

In Aristotelian physics, prime matter, of which all physical substances are composed, is, like God Himself, eternal and uncreated. It underlies the eternal process of generation and corruption undergone by things in the sub-lunary realm. In its large-scale structure the universe has remained unchanged from all eternity.

Even with the demise of Aristotelian physics in the scientific revolution completed by Isaac Newton, the assumption of a static universe remained unchallenged. Although Newton himself believed that God had created the world, the universe described by his physics was to all appearances eternal. The assumption that the universe was never created was only further reinforced by Hermann Helmholtz's statement in the nineteenth century of the laws of the conservation of matter and energy. Since matter and energy can be neither created nor destroyed, there must have always been and will always be a universe, that is to say, the universe is temporally infinite in the past and the future.

To be sure, there were already clues in pre-relativistic physics–like Olbers's Paradox of why the night sky is dark rather than aflame with light if an infinity of stars has existed from eternity past, or like the Second Law of Thermodynamics, which seemed to imply that the universe, if it has existed from eternity, ought to lie moribund in a state of equilibrium–, that there was something wrong with the prevailing assumption of an eternal, static cosmos. But these niggling worries could not overturn what was everywhere taken for granted: that the universe as a whole has existed and will exist unchanged forever.

The Revolution Wrought by General Relativity

Tremors of the impending earthquake which would demolish the old cosmology were first felt in 1917, when Albert Einstein made a cosmological application of his newly discovered gravitational theory, the General Theory of Relativity (hereafter, GR). [6] Einstein assumed that the universe is homogeneous and isotropic and that it exists in a steady state, with a constant mean mass density and a constant curvature of space. To his chagrin, however, he found that GR would not permit such a model of the universe unless he introduced into his gravitational field equations a certain "fudge factor" L in order to counterbalance the gravitational effect of matter and so ensure a static universe. Einstein's static universe was balanced on a razor's edge, however, and the least perturbation–even the transport of matter from one part of the universe to another–would cause the universe either to implode or to expand. By taking this feature of Einstein's model seriously, the Russian mathematician Alexander Friedman and the Belgian astronomer Georges Lemaître were able to formulate independently in the 1920s solutions to the field equations which predicted an expanding universe. [7]

The monumental significance of the Friedman-Lemaître model lay in its historization of the universe. As one commentator has remarked, up to this time the idea of the expansion of the universe "was absolutely beyond comprehension. Throughout all of human history the universe was regarded as fixed and immutable and the idea that it might actually be changing was inconceivable." [8] But if the Friedman-Lemaître model were correct, the universe could no longer be adequately treated as a static entity existing, in effect, timelessly. Rather the universe has a history, and time will not be matter of indifference for our investigation of the cosmos.

In 1929 the American astronomer Edwin Hubble's measurements of the red-shift in the optical spectra of light from distant galaxies, [9] which was taken to indicate a universal recessional motion of the light sources in the line of sight, provided a dramatic verification of the Friedman-Lemaître model. Incredibly, what Hubble had discovered was the isotropic expansion of the universe predicted by Friedman and Lemaître on the basis of Einstein's GR. It was a veritable turning point in the history of science. "Of all the great predictions that science has ever made over the centuries," exclaims John Wheeler, "was there ever one greater than this, to predict, and predict correctly, and predict against all expectation a phenomenon so fantastic as the expansion of the universe?" [10]

The Standard Big Bang Model

According to the Friedman-Lemaître model, as time proceeds, the distances separating galactic masses become greater. It is important to understand that as a GR-based theory, the model does not describe the expansion of the material content of the universe into a pre-existing, empty, Newtonian space, but rather the expansion of space itself. The ideal particles of the cosmological fluid constituted by the matter and energy of the universe are conceived to be at rest with respect to space but to recede progressively from one another as space itself expands or stretches, just as buttons glued to the surface of a balloon would recede from one another as the balloon inflates. As the universe expands, it becomes less and less dense. This has the astonishing implication that as one reverses the expansion and extrapolates back in time, the universe becomes progressively denser until one arrives at a state of infinite density at some point in the finite past. This state represents a singularity at which space-time curvature, along with temperature, pressure, and density, becomes infinite. It therefore constitutes an edge or boundary to space-time itself. P. C. W. Davies comments,

If we extrapolate this prediction to its extreme, we reach a point when all distances in the universe have shrunk to zero. An initial cosmological singularity therefore forms a past temporal extremity to the universe. We cannot continue physical reasoning, or even the concept of spacetime, through such an extremity. For this reason most cosmologists think of the initial singularity as the beginning of the universe. On this view the big bang represents the creation event; the creation not only of all the matter and energy in the universe, but also of spacetime itself. [11]

The term “Big Bang,” originally a derisive expression coined by Fred Hoyle to characterize the beginning of the universe predicted by the Friedman-Lemaître model, is thus potentially misleading, since the expansion cannot be visualized from the outside (there being no “outside,” just as there is no “before” with respect to the Big Bang).

The standard Big Bang model, as the Friedman-Lemaître model came to be called, thus describes a universe which is not eternal in the past, but which came into being a finite time ago. Moreover, –and this deserves underscoring–the origin it posits is an absolute origin *ex nihilo*. For not only all matter and energy, but space and time themselves come into being at the initial cosmological singularity. As John Barrow and Frank Tipler emphasize, “At this singularity, space and time came into existence; literally nothing existed before the singularity, so, if the Universe originated at such a singularity, we would truly have a creation *ex nihilo.*” [12] On the standard model the universe originates *ex nihilo* in the sense that at the initial singularity it is true that *There is no earlier space-time point* or it is false that *Something existed prior to the singularity.*

Beginningless Models

Although advances in astrophysical cosmology have forced various revisions in the standard model [13], nothing has called into question its fundamental prediction of the finitude of the past and the beginning of the universe. Indeed, as James Sinclair has shown, the history of 20th century cosmogony has seen a parade of failed theories trying to avert the absolute beginning predicted by the standard model. [14] These beginningless models have been repeatedly shown either to be physically untenable or to imply the very beginning of the universe which they sought to avoid. Meanwhile, a series of remarkable singularity theorems has increasingly tightened the loop around empirically tenable cosmogonic models by showing that under more and more generalized conditions, a beginning is inevitable. In 2003 Arvind Borde, Alan Guth, and Alexander Vilenkin were able to show that any universe which is, on average, in a state of cosmic expansion throughout its history cannot be infinite in the past but must have a beginning. [15] In 2012 Vilenkin showed that cosmogonic models which do not fall under this single condition fail on other grounds to avert the beginning of the universe. Vilenkin concluded, “There are no models at this time that provide a satisfactory model for a universe without a beginning.” [16] In an article in the online journal *Inference* published in the fall of 2015 Vilenkin strengthened that conclusion: “We have no viable models of an eternal universe. The BGV theorem gives reason to believe that such models simply cannot be constructed.” [17]

Cosmologist Sean Carroll, in an effort to subvert the implications of the Borde-Guth-Vilenkin theorem, has recently cited privately communicated remarks from Alan Guth to the effect that “I don’t know whether the universe had a beginning. I suspect that the universe *didn’t* have a beginning. It’s very likely eternal–but nobody knows.” [18] Carroll rightly asks, “Now, how in the world can the author of the Borde-Guth-Vilenkin theorem say the universe is probably eternal?” [19] More aptly, how can one of its authors say that it is probably eternal and the other that it is probably not? Carroll assured his audience that the reason is that “The theorem is only about classical descriptions of the universe, not about the universe itself.” [20] That would not, however, explain how Vilenkin could be so desperately mistaken about the theorem’s implications. But now new light has been shed on Guth’s enigmatic remarks through correspondence with the philosopher Daniel Came. [21] There Guth reveals that he favors models of the universe featuring a reversal of time’s arrow at some point in the past and that his remarks to Carroll had reference to such models. Such models do not fall under the BGV theorem because they do not satisfy the single condition of that theorem, that the universe is, on average, in a state of cosmic expansion throughout its history. Thus, neither Guth nor Vilenkin is mistaken about the theorem’s implications; rather Guth just advocates a model to which the theorem does not apply. Unfortunately for hopefuls of a past-eternal universe like Guth and Carroll, such time-reversal models are highly unphysical and, even if successful, do not in fact avert the beginning of the universe but rather imply it. [22] For that time-reversed expansion is in no sense in our past but represents a universe sharing the same beginning point but expanding in another direction.

Vilenkin had already considered such models in his previous discussions and rejected them. That is why he said, “All the evidence we have says that the universe had a beginning.” [23]

The Borde-Guth-Vilenkin theorem proves that classical spacetime, under a single, very general condition, cannot be extended to past infinity but must reach a boundary at some time in the finite past. Now either there was something on the other side of that boundary or not. If not, then that boundary is the beginning of the universe. If there was something on the other side, then it will be a non-classical region described by the yet to be discovered theory of quantum gravity. In that case, Vilenkin says, *it* will be the beginning of the universe. [24]

For consider: If there is such a non-classical region, then it is not past eternal in the classical sense. But neither does it seem to exist literally timelessly, akin to the way in which philosophers consider abstract objects to be timeless or theologians take God to be timeless. For it is supposed to have existed *before* the classical era, and the classical era is supposed to have *emerged* from it, which seems to posit a temporal relation between the quantum gravity era and the classical era. [25] In any case, such a quantum state is not stable and so would either produce the universe from eternity past or not at all. As Anthony Aguirre and John Kehayias argue,

it is very difficult to devise a system – especially a quantum one – that does nothing ‘forever,’ then evolves. A truly stationary or periodic quantum state, which would last forever, would never evolve, whereas one with any instability will not endure for an indefinite time. [26]

Hence, the quantum gravity era would itself have to have had a beginning in order to explain why it transitioned just some 14 billion years ago into classical time and space. Hence, whether at the boundary or at the quantum gravity regime, the universe began to exist.

The Thermodynamics of the Universe

If this were not enough, there is a second line of scientific evidence for the beginning of the universe based on the laws of thermodynamics. According to the Second Law of Thermodynamics, processes taking place in a closed system always tend toward a state of equilibrium. Now our interest in the law is what happens when it is applied to the universe as a whole. The universe is, on a naturalistic view, a gigantic closed system, since it is everything there is and there is nothing outside it. What this seems to imply then is that, given enough time, the universe and all its processes will run down, and the entire universe will come to equilibrium. This is known as the heat death of the universe. Once the universe reaches this state, no further change is possible. The universe is dead.

Now the question that this implication of the Second Law inevitably forces upon us is the following: *If, given enough time, the universe will reach heat death, then why is it not in a state of heat death now, if it has existed forever, from eternity?* If the universe did not begin to exist, then it should now be in a state of equilibrium. Like a ticking clock, it should by now have run down. Since it has not yet run down, this implies, in the words of one baffled scientist, “In some way the universe must have been *wound up.*” [27]

Pre-Relativistic Physics

As alluded to earlier, nineteenth century physicists were already aware of this conundrum. The German scientist Ludwig Boltzmann offered a daring proposal in order to explain why we do not find the universe in a state of “heat death” or thermodynamic equilibrium. [28] Boltzmann hypothesized that the universe as a whole *does*, in fact, exist in an equilibrium state, but that over time fluctuations in the energy level occur here and there throughout the universe, so that by chance alone there will be isolated regions where disequilibrium exists. Boltzmann referred to these isolated regions as “worlds.” We should not be surprised to see our world in a highly improbable disequilibrium state, he maintained, since in the ensemble of all worlds there must exist by chance alone certain worlds in disequilibrium, and ours just happens to be one of these.

The problem with Boltzmann’s daring Many Worlds Hypothesis is that if our world were merely a fluctuation in a sea of diffuse energy, then it is overwhelmingly more probable that we should be observing a much tinier region of disequilibrium than we do. In order for us to exist, a smaller fluctuation, even one that produced our world instantaneously by an enormous accident, is inestimably more probable than a progressive decline in entropy over 14 billion years to fashion the world we see. In fact, Boltzmann’s hypothesis, if adopted, would force us to regard the past as illusory, everything having the mere appearance of age, and the stars and planets as illusory, mere “pictures” as it were, since that sort of world is vastly more probable given a state of overall equilibrium than a world with genuine, temporally and spatially distant events. Therefore, Boltzmann’s Many Worlds Hypothesis has been universally rejected by the scientific community, and the present disequilibrium is usually taken to be just a result of the initial low entropy condition mysteriously obtaining at the beginning of the universe.

General Relativistic Physics

Today eschatology is no longer merely a branch of theology; rather it has become a field of cosmology. Just as cosmogony studies the origin of the universe, so physical eschatology studies its end. In contemporary cosmological eschatology there are two possible types of heat death for for the universe. If the universe will eventually re-contract, it will die a “hot” death. Beatrice Tinsley describes such a state:

If the average density of matter in the universe is great enough, the mutual gravitational attraction between bodies will eventually slow the expansion to a halt. The universe will then contract and collapse into a hot fireball. There is no known physical mechanism that could reverse a catastrophic big crunch. Apparently, if the universe becomes dense enough, it is in for a hot death. [29]

If the universe is fated to re-contraction, then as it contracts the stars gain energy, causing them to burn more rapidly so that they finally explode or evaporate. As everything in the universe grows closer together, the black holes begin to gobble up everything around them, and eventually begin themselves to coalesce. In time, “All the black holes finally coalesce into one large black hole that is coextensive with the universe,” [30] from which the universe will never re-emerge.

But suppose, as is more likely, that the universe will expand forever. Tinsley describes the fate of this universe:

If the universe has a low density, its death will be cold. It will expand forever at a slower and slower rate. Galaxies will turn all of their gas into stars, and the stars will burn out. Our own sun will become a cold, dead remnant, floating among the corpses of other stars in an increasingly isolated Milky Way. [31]

At 1030 years the universe will consist of 90% dead stars, 9% supermassive black holes formed by the collapse of galaxies, and 1% atomic matter, mainly hydrogen. Elementary particle physics suggests that thereafter protons will decay into electrons and positrons, so that space will be filled with a rarefied gas so thin that the distance between an electron and a positron will be about the size of the present galaxy. At 10^{100} years, some scientists believe that the black holes themselves will dissipate by a strange effect predicted by quantum mechanics. The mass and energy associated with a black hole so warp space that they are said to create a “tunnel” or “worm-hole” through which the mass and energy are ejected in another region of space. As the mass of a black hole decreases, its energy loss accelerates, so that it is eventually dissipated into radiation and elementary particles. Eventually all black holes will completely evaporate and all the matter in the ever-expanding universe will be reduced to a thin gas of elementary particles and radiation. Because the volume of space constantly increases, the universe will never actually arrive at equilibrium, since there is always more room for entropy production. Nonetheless, the universe will become increasingly cold, dark, dilute, and dead.

Recent discoveries provide strong evidence that there is effectively a positive cosmological constant which causes the cosmic expansion to accelerate rather than decelerate. Paradoxically, since the volume of space increases exponentially, allowing greater room for further entropy production, the universe actually grows farther and farther from an equilibrium state as time proceeds. But the acceleration only hastens the cosmos's disintegration into increasingly isolated material patches no longer causally connected with similarly marooned remnants of the expanding universe. Each of these patches faces, in turn, thermodynamic extinction. Therefore, the grim future predicted on the basis of the second law remains fundamentally unaltered.

Thus, the same pointed question raised by classical physics persists: why, if the universe has existed forever, is it not now in a cold, dark, dilute, and lifeless state? In contrast to their nineteenth century forbears, contemporary physicists have come to question the implicit assumption that the universe is past eternal. Davies, an expert in the physics of temporally asymmetrical processes, reports,

Today, few cosmologists doubt that the universe, at least as we know it, did have an origin at a finite moment in the past. The alternative—that the universe has always existed in one form or another—runs into a rather basic paradox. The sun and stars cannot keep burning forever: sooner or later they will run out of fuel and die.

The same is true of all irreversible physical processes; the stock of energy available in the universe to drive them is finite, and cannot last for eternity. This is an example of the so-called second law of thermodynamics, which, applied to the entire cosmos, predicts that it is stuck on a one-way slide of degeneration and decay towards a final state of maximum entropy, or disorder. As this final state has not yet been reached, it follows that the universe cannot have existed for an infinite time. [32]

Davies concludes, "The universe can't have existed forever. We know there must have been an absolute beginning a finite time ago."

Multiverse Scenarios

Inflationary theory has been exploited by some theorists in an attempt to revive Boltzmann's explanation of why we find ourselves in a universe thermodynamically capable of sustaining observers. According to generic inflationary theory, our universe exists in a true vacuum state with an energy density that is nearly zero; but earlier it existed in a false vacuum state with a very high energy density. If we hypothesize that the conditions determining the energy density and evolution of the false vacuum state were just right, then the false vacuum will expand so rapidly that, as it decays into bubbles of true vacuum, the "bubble universes" formed in this sea of false vacuum, though themselves expanding at enormous rates, will not be able to keep up with the expansion of the false vacuum and so will find themselves increasingly separated with time.

Moreover, each bubble is subdivided into domains bounded by event horizons, each domain constituting an observable universe. Observers internal to such a universe will observe it to be open and infinite, even though externally the bubble universe is finite and geometrically closed. Despite the fact that the multiverse is itself finite and geometrically closed, the false vacuum will, according to the theory, go on expanding forever. New bubbles of true vacuum will continue to form in the gaps between the bubble universes and become themselves isolated worlds. The question then, in the words of Dyson, Kleban, and Susskind, is "whether the universe can be a naturally occurring fluctuation, or must it be due to an external agent which starts the system out in a specific low entropy state?" [33]

The proposed solution to the problem is essentially the same as Boltzmann's. Among the infinity of worlds generated by inflation there will be some worlds that are in a state of thermodynamic disequilibrium, and only such worlds can support observers. It is therefore not surprising that we find the world in a state of disequilibrium, since that is the only kind of world that we could observe.

But then the proposed solution is plagued by the same failing as Boltzmann's hypothesis. In a multiverse of eternally inflating vacua most of the volume will be occupied by high entropy, disordered states incapable of supporting observers. There are two ways in which observable states can exist: first, by being part of a relatively young, low entropy world, or, second, by being a thermal fluctuation in a high entropy world. Even though young universes are constantly nucleating out of the false vacuum, their volumes will be small in comparison with the older bubbles. Disordered states will therefore be on average strongly predominant. That implies that observers are much more likely to be the result of thermal fluctuations than the result of young, low entropy conditions.

But then the objection once again arises that it is incomprehensibly more probable that a much smaller region of disequilibrium should arise via a fluctuation than a region as large as our observable universe. Roger Penrose calculates that the odds of our universe's initial low entropy condition's coming into existence is on the order of one part in 10(123). [34] He comments, "I cannot even recall seeing anything else in physics whose accuracy is known to approach, even remotely, a figure like one part in 10^{10} (123)." [35] By contrast, the odds of our solar system's being formed instantly by random collisions of particles is about 1:10^{10}(60), a vast number, but inconceivably smaller than 10^{10}(123). (Penrose calls it "utter chicken feed" by comparison. [36]) Thus, in the multiverse of worlds, observable states involving such an initial low entropy condition will be an incomprehensibly tiny fraction of all the observable states there are. If we are just one random member of an ensemble of worlds, we should therefore be observing a smaller patch of order.

Adopting the multiverse hypothesis to explain our ordered observations would thus result once more in a strange sort of illusionism. It would be overwhelmingly probable that there is really not a vast, orderly universe out there, despite our observations; it is all an illusion. Indeed, the most probable state which is adequate to support our ordered observations is an even smaller “universe” consisting of a single brain which appears out of the disorder via a thermal fluctuation. In all probability, then, you alone exist, and even your physical body is illusory! Some cosmologists have, in melodramatic language reminiscent of grade-B horror movies of the 1950s, dubbed this problem “the invasion of the Boltzmann brains.” [37] Boltzmann brains are much more plenteous in the ensemble of universes than ordinary observers, and, therefore, each of us ought to think that he is himself a Boltzmann brain if he believes that the universe is but one member of an ensemble of worlds. Since that seems crazy, that fact strongly disconfirms the hypothesis that there is a multiverse old enough and big enough to have evolved sufficient volume to account for our low entropy condition’s appearing by chance. These and other problems make the multiverse solution less plausible than the standard solution that the universe began to exist with an initial low entropy condition.

Quantum Cosmology

Those preferring a beginningless universe might hope that quantum cosmology might serve to avert the implications of the second law of thermodynamics. But now a new singularity theorem formulated by Aron Wall seems to close the door on that possibility. Wall shows that, given the validity of the generalized second law of thermodynamics in quantum cosmology, the universe must have begun to exist, unless, with Guth, one postulates a reversal of the arrow of time at some point in the past, which, Wall rightly observes, involves a thermodynamic beginning in time which “would seem to raise the same sorts of philosophical questions that any other sort of beginning in time would.” [38] Wall reports that his results require only certain basic concepts, so that “it is reasonable to believe that the results will hold in a complete theory of quantum gravity.” [39]

Thus, we have good evidence both from the expansion of the universe and from the second law of thermodynamics that the universe is not past eternal but had a temporal beginning.

Creation *ex nihilo*

Davies raises the inevitable question:

‘What caused the big bang?’ . . . One might consider some supernatural force, some agency beyond space and time as being responsible for the big bang, or one might prefer to regard the big bang as an event without a cause. It seems to me that we don’t have too much choice. Either . . . something outside of the physical world . . . or . . . an event without a cause. [40]

It might seem metaphysically absurd that the universe should come into being without a cause and therefore a supernatural agency is to be preferred. But some scientists have contended that quantum physics can explain the origin of the universe from nothing.

“Nothing”

Unfortunately, some of these scientists have an outrageously naïve grasp of language. The word “nothing” is a term of universal negation. It means “not anything.” So, for example, if I say, “I had nothing for lunch today,” I mean, “I did not have anything for lunch today.” If you read an account of World War II in which it says that “Nothing stopped the German advance from sweeping across Belgium,” it means that the German advance was not stopped by anything. If a theologian tells you that God created the universe out of nothing, he means that God’s creation of the universe was not out of anything. The word “nothing,” to repeat, is simply a term of universal negation, meaning “not anything.”

There is a whole series of similar words of universal negation in English: “nobody” means not anybody. “None” means not one. “Nowhere” means not anywhere. “No place” means not in any place.

Now because the word “nothing” is grammatically a pronoun, we can use it as the subject or direct object of a sentence. By taking these words, not as terms of universal negation, but as words referring to something, we can generate all sorts of funny situations. If you say, “I saw nobody in the hall,” the wiseacre replies, “Yeah, he’s been hanging around there a lot lately.” If you say, “I had nothing for lunch today,” he says, “Really? How did it taste?”

These sorts of puns are as old as literature itself. In Homer’s *Odyssey*, Odysseus introduces himself to the Cyclops as “No man” or “Nobody.” One night Odysseus puts out the Cyclops’ eye. His fellow Cyclopses hear him screaming and yell to him, “What’s the matter with you, making so much noise that we can’t sleep?” The Cyclops answers, “Nobody is killing me! Nobody is killing me!” They reply, “If nobody is attacking you, then you must be sick, and there’s nothing we can do about it!” In Euripides’ version of the story, he composes a sort of Abbott and Costello “Who’s on first?” routine:

“Why are you crying out, Cyclops?”
“Nobody has undone me!”
“Then there is no one hurting you after all.”
“Nobody is blinding me!”
“Then you’re not blind.”
“As blind as you!”

“How could nobody have made you blind?”
“You’re mocking me! But where is this Nobody?”
“Nowhere, Cyclops!”

The use of these words of negation like “nothing,” “nobody,” and “no one” as substantive words referring to something *is a joke*.

How astonishing, then, to find that some physicists, whose mother tongue is English, have used these terms precisely as substantive terms of reference. Lawrence Krauss, for example, has told us with a straight face that:

“There are a variety of forms of nothing, [and] they all have physical definitions.”
“The laws of quantum mechanics tell us that nothing is unstable.”
“70% of the dominant stuff in the universe is nothing.”
“There’s nothing there, but it has energy.”
“Nothing weighs something.”
“Nothing is almost everything.” [41]

All of these claims take the word “nothing” to be a substantive term referring to something, for example, the quantum vacuum or quantum fields. These are physical realities and therefore clearly something. To call these realities nothing is at best misleading, guaranteed to confuse laypeople, and at worst a deliberate misrepresentation of science. Such statements do not even begin to address, much less answer, the question why the universe exists rather than nothing.

In his review of Krauss’ book *A Universe from Nothing*, David Albert, an eminent philosopher of quantum physics, explains with respect to Krauss’ first kind of nothing,

vacuum states are particular arrangements of elementary physical stuff. . . . the fact that some arrangements of fields happen to correspond to the existence of particles and some don’t is not a whit more mysterious than the fact that some of the possible arrangements of my fingers happen to correspond to the existence of a fist and some don’t. And the fact that particles can pop in and out of existence, over time, as those fields rearrange themselves, is not a whit more mysterious than the fact that fists can pop in and out of existence, over time, as my fingers rearrange themselves. And none of these poppings . . . amount to anything even remotely in the neighborhood of a creation from nothing. . . . [42]

He concludes, “Krauss is dead wrong and his religious and philosophical critics are absolutely right.”

Coming into Being from Nothing

Alexander Vilenkin has a different proposal as to how the universe could come into being from literally nothing. In response to the claim of a supernatural agency, he says,

Regarding the BGV theorem and its relation to God, I think the theorem implies the existence of a rather special state at the past boundary of classical spacetime. Some mechanism is required to impose this state. Craig wants this mechanism to be God, but I think quantum cosmology would do just as well. [43]

Just what does Vilenkin have in mind? In his *Inference* article, he explains,

Modern physics can describe the emergence of the universe as a physical process that does not require a cause. Nothing can be created from nothing, says Lucretius, if only because the conservation of energy makes it impossible to create nothing [*sic*; something?] from nothing. . . .

There is a loophole in this reasoning. The energy of the gravitational field is negative; it is conceivable that this negative energy could compensate for the positive energy of matter, making the total energy of the cosmos equal to zero. In fact, this is precisely what happens in a closed universe, in which the space closes on itself, like the surface of a sphere. It follows from the laws of general relativity that the total energy of such a universe is necessarily equal to zero....

If all the conserved numbers of a closed universe are equal to zero, then there is nothing to prevent such a universe from being spontaneously created out of nothing. And according to quantum mechanics, any process which is not strictly forbidden by the conservation laws will happen with some probability. . . .

What causes the universe to pop out of nothing? No cause is needed. [44]

I think this is a terrible argument. Grant the supposition that the positive energy associated with matter is exactly counter-balanced by the negative energy associated with gravity, so that on balance the energy is zero. The key move comes with the claim that in such a case “there is nothing to prevent such a universe from being spontaneously created out of nothing.” Now this claim is a triviality. Necessarily, if there is nothing, then there is nothing to prevent the universe from coming into being. By the same token, if there is nothing, then there is nothing to permit the universe to come into being. If there were anything to prevent or permit the universe’s coming into being, then there would be something, not nothing. If there is nothing, then there is nothing, period.

The absence of anything to prevent the universe’s coming into being does not imply the metaphysical possibility of the universe’s coming into being from nothing. To illustrate, if there were nothing, then there would be nothing to prevent God's coming into being without a cause, but that does not entail that such a thing is metaphysically possible. It is metaphysically impossible for God to come into being without a cause, even if there were nothing to prevent it because nothing existed.

Vilenkin, however, infers that "no cause is needed" for the universe's coming into being because the conservation laws would not prevent it and "according to quantum mechanics, any process which is not strictly forbidden by the conservation laws will happen." The argument assumes that if there were nothing, then both the conservation laws and quantum physical laws would still hold. This is far from obvious, however, since in the absence of anything at all, it is not clear that the laws governing our universe would hold. In any case, why think that, given the laws of quantum mechanics, anything not strictly forbidden by the conservation laws will happen? The conservation laws do not strictly forbid God's sending everyone to heaven, but that hardly gives grounds for optimism. Neither do they strictly forbid His sending everyone to hell, in which case both outcomes will occur, which is logically impossible, as they are logically contrary universal generalizations. The point can be made non-theologically as well: the conservation laws do not strictly forbid something's coming into existence, but neither do they forbid nothing's coming into existence, but both cannot happen. It is logically absurd to think that because something is not forbidden by the conservation laws, it will therefore happen.

Finally, Vilenkin's inference that because the positive and negative energy in the universe sum to zero, therefore no cause of the universe's coming into being is needed is hard to take seriously. This is like saying that if your debts balance your assets, then your net worth is zero, and so there is no cause of your financial situation! Vilenkin would, I hope, not agree with Peter Atkins that because the positive and negative energy of the universe sum to zero, therefore nothing exists now, and so "Nothing did indeed come from nothing." [45] For as Descartes taught us, I, at least, undeniably exist, and so something exists. Christopher Isham, Britain's premier quantum cosmologist, rightly points out that there still needs to be "ontic seeding" to create the positive and negative energy in the first place, even if on balance its sum is naught. [46] Even if one were to concede the absence of a material cause of the universe, the need of an efficient cause is patent.

Conclusion

We thus have two independent lines of scientific evidence in support of the beginning of the universe. First, the expansion of the universe implies that the universe had a beginning. Second, thermodynamics shows the universe began to exist. Because these lines of evidence are independent and mutually reinforcing, the confirmation they supply for a beginning of the universe is all the stronger. Of course, as with all scientific results, this evidence is provisional. As Sean

Carroll reminds us,

Science isn’t in the business of proving things. Rather, science judges the merits of competing models in terms of their simplicity, clarity, comprehensiveness, and fit to the data. Unsuccessful theories are never disproven, as we can always concoct elaborate schemes to save the phenomena; they just fade away as better theories gain acceptance. [47]

Science cannot force us to accept the beginning of the universe; one can always concoct elaborate schemes to explain away the evidence. But those schemes have not fared well in displaying the aforementioned scientific virtues.

Given the metaphysical impossibility of the universe’s coming into being from nothing, belief in a supernatural Creator is eminently reasonable. At the very least we can say confidently that the person who believes in the doctrine of *creatio ex nihilo* will not find himself contradicted by the empirical evidence of contemporary cosmology but on the contrary fully in line with it.

Footnotes

[1] See chaps 1-2 of Paul Copan and William Lane Craig, Creation out of Nothing: A Biblical, Philosophical, and Scientific Exploration (Grand Rapids, Mich.: Baker Bookhouse, 2004).

[2] See again Copan and Craig, Creation out of Nothing, chap. 3.

[3] See William Lane Craig, The Kalām Cosmological Argument (London: Macmillan & Co., 1979).

[4] “creator omnium invisibilium et visibilium, spiritualium et corporalium, qui sua omnipotenti virtute simul ab initio temporis, utramque de nihilo conditit creaturam, spiritualem et corporalem” (Concilium Lateranense IV, Consitutiones 1. De fide catholica).

[5] See once more Copan and Craig, Creation out of Nothing, chaps. 4-6.

[6] A. Einstein, “Cosmological Considerations on the General Theory of Relativity,” in The Principle of relativity, by A. Einstein, et. al., with Notes by A. Sommerfeld, trans. W. Perrett and J. B. Jefferey (re ed.: New York: Dover Publications, 1952), 177-88.

[7] A. Friedman, “Über die Krümmung des Raumes,” Zeitschrift für Physik 10 (1922): 377-86; G. Lemaître, “Un univers homogène de masse constante et de rayon croissant, rendant compte de la vitesse radiale des nébuleuses extragalactiques,” Annales de la Société scientifique de Bruxelles 47 (1927): 49-59.

[8] Gregory L. Naber, Spacetime and Singularities: an Introduction (Cambridge: Cambridge University Press, 1988), 126-7.

[9] E. Hubble, “A Relation between Distance and Radial Velocity among Extra-galactic Nebulae,” Proceedings of the National Academy of Sciences 15 (1929): 168-73.

[10] John A. Wheeler, “Beyond the Hole,” in Some Strangeness in the Proportion, ed. Harry Woolf (Reading, Mass.: Addison-Wesley, 1980), 354.

[11] P. C. W. Davies, “Spacetime Singularities in Cosmology,” in The Study of Time III, ed. J. T. Fraser (New York: Springer Verlag, 1978), 78-79.

[12] John Barrow and Frank Tipler, The Anthropic Cosmological Principle (Oxford: Clarendon Press, 1986), 442.

[13] Principally the addition of an early inflationary era and an accelerating expansion.

[14] William Lane Craig and James Sinclair, “The Kalam Cosmological Argument,” in The Blackwell Companion to Natural Theology, ed. Wm. L. Craig and J. P. Moreland (Oxford: Wiley-Blackwell, 2009), pp. 101-201; idem, “On Non-Singular Spacetimes and the Beginning of the Universe,” in Scientific Approaches to the Philosophy of Religion, ed. Yujin Nagasawa, Palgrave Frontiers in Philosophy of Religion (London: Macmillan, 2012), pp. 95-142.

[15] A. Borde, A. Guth, A. Vilenkin, “Inflationary Spacetimes Are Incomplete in Past Directions,” Physical Review Letters 90 (2003): 151301, http://arxiv.org/abs/gr-qc/0110012.

[16] Alexander Vilenkin, “Did the universe have a beginning?” http://www.youtube.com/watch?v=NXCQelhKJ7A. Cf. Audrey Mithani and Alexander Vilenkin, “Did the universe have a beginning?” arXiv:1204.4658v1 [hep-th] 20 Apr 2012, p. 1, where they state: “None of these scenarios can actually be past-eternal.”

[17] Alexander Vilenkin, “The Beginning of the Universe,” Inference: International Review of Science 1/ 4 (Oct. 23, 2015), http://inference-review.com/article/the-beginning-of-the-universe.

[18] Robert Stewart, ed., God and Cosmology: William Lane Craig and Sean Carroll in Dialogue (Minneapolis: Fortress Press, 2016), p. 70. The Greer-Heard Forum itself was held in 2014.

[19] Ibid.

[20] Ibid.

[21] Alan Guth to Daniel Came, 19 March 2017, cited by Came in our debate “Does God Exist?” at Trinity College, Dublin, March 23, 2017, available at https://www.facebook.com/reasonablefaithorg/videos/10154698973823229/ .

[22] See Alexander Vilenkin, “Arrows of time and the beginning of the universe,” arXiv:1305.3836v2 [hep-th] 29 May 2013; also Craig and Sinclair, “The Kalām Cosmological Argument,” p. 157.

[23] A.Vilenkin, cited in “Why physicists can’t avoid a creation event,” by Lisa Grossman, New Scientist (January 11, 2012).

[24] “If indeed all past-directed geodesics encounter a quantum spacetime region where the notions of time and causality no longer apply, I would characterize such a region as the beginning of the universe” (A. Vilenkin to William Lane Craig, personal correspondence, December 8, 2013).

[25] Christopher Isham observes that although quantum cosmogonies “differ in their details they all agree on the idea that space and time emerge in some way from a purely quantum-mechanical region which can be described in some respects as if it were a classical, imaginary-time four-space” (C. J. Isham, “Quantum Theories of the Creation of the Universe,” in Quantum Cosmology and the Laws of Nature, second ed., ed. Robert J. Russell et al. [Vatican City State: Vatican Observatory, 1996], p. 75). This feature of quantum cosmogony is very problematic, since diachronic emergence of time is obviously incoherent (J. Butterfield and C. J. Isham, “On the Emergence of Time in Quantum Gravity,” in The Arguments of Time, ed. J. Butterfield [Oxford University Press, 1999], pp. 111-68; Vincent Lam and Michael Esfeld, “A dilemma for the emergence of spacetime in canonical quantum gravity,” Studies in History and Philosophy of Modern Physics 44 [2013]: 286–293; Reiner Hedrich, “Hat die Raumzeit Quanteneigenschaften? – Emergenztheoretische Ansätze in der Quantengravitation,” in Philosophie der Physik, ed. M. Esfeld [Berlin: Suhrkamp, forthcoming], pp. 287-305). But how can one make sense of a synchronic emergence of time as a supervenient reality in the context of cosmogony? The authors cited do not tell us. The best sense I can make of it is to say that the Euclidian description is a lower-level description of classical spacetime prior to the Planck time. (One recalls Hawking’s

remark that when we go back to the real time in which we live, there still would be singularities.) So the same reality is being described at two levels. That implies that if the classical spacetime has a beginning, then so does the quantum gravity regime. For they are descriptions of the same reality. In the one a singularity is part of the description; in the other it is not. So what is prior to the Planck time is not the quantum gravity era as such; rather what is prior is the classical period of which the quantum gravity description is the more fundamental description. If this is correct, then, given the beginning of the classically described universe, it is impossible for the universe as quantum gravitationally described to be without a beginning. For they just are the same universe at different levels of description.

[26] Anthony Aguirre and John Kehayias, “Quantum Instability of the Emergent Universe,” arXiv:1306.3232v2 [hep-th] 19 Nov 2013. They are specifically addressing the Ellis-Maarten model, but their point is generalizable.

[27] Richard Schlegel, “Time and Thermodynamics,” in The Voices of Time,ed. J. T. Fraser (London: Penguin, 1968), p. 511.

[28]

Ludwig Boltzmann, Lectures on Gas Theory, trans. Stephen G. Brush (Berkeley: University of California Press, 1964), §90 (446-448).

[29] Beatrice Tinsley, “From Big Bang to Eternity?” Natural History Magazine, October 1975, p. 103.

[30] Duane Dicus et al., “The Future of the Universe,” Scientific American (March 1983): 99.

[31] Tinsley, “Big Bang,” p. 105.

[32] Paul Davies, “The Big Bang—And Before,” The Thomas Aquinas College Lecture Series, Thomas Aquinas College, Santa Paula, Calif., March 2002.

[33] Lin Dyson, Matthew Kleban, and Leonard Susskind, “Disturbing Implications of a Cosmological Constant,” http://arXiv.org/abs/hep-th/0208013v3 (14 November 2002), p. 4. Their point of departure is Henri Poincaré’s argument that in a closed box of randomly moving particles every configuration of particles, no matter how improbable, will eventually recur, given enough time; given infinite time, every configuration will recur infinitely many times. Eschewing a global perspective in favor of a restriction to our causally connected patch of the universe, they argue for the inevitability of cosmological Poincaré recurrences, allowing the process of cosmogony to begin anew. N.B. that even if bubble universes decay before the Poincaré recurrences could happen, there is still enough time for the invasion of Bolztmann brains, discussed below.

[34] Roger Penrose, “Time-Asymmetry and Quantum Gravity,” in Quantum Gravity 2, ed. C. J. Isham, R. Penrose, and D. W. Sciama (Oxford: Clarendon Press, 1981), p. 249; cf. Stephen Hawking and Roger Penrose, The Nature of Space and Time, The Isaac Newton Institute Series of Lectures (Princeton, N. J.: Princeton University Press, 1996), pp. 34-5.

[35] Penrose, “Time-Asymmetry,” p. 249.

[36] Roger Penrose, The Road to Reality (New York: Alfred A. Knopf, 2005), pp. 762-5.

[37] For literature see Don N. Page, “Return of the Boltzmann Brains,” (15 November 2006), http://arXiv:hep-th/0611158.

[38] Aron C. Wall, “The Generalized Second Law implies a Quantum Singularity Theorem,” arXiv: 1010.5513v3 [gr-qc] 24 Jan 2013, p. 38.

[39] Ibid., p. 4.

[40] Paul Davies, “The Birth of the Cosmos,” in God, Cosmos, Nature and Creativity, ed. Jill Gready (Edinburgh: Scottish Academic Press, 1995), pp. 8-9.

[41] All of these quotations are from Krauss’s videos posted on YouTube, including his Asimov Memorial “Nothing Debate” 1:20:25; American Atheists lecture 26:23; Richard Fidler interview; discussion with Richard Dawkins at Arizona State Origins Project 37min.; and Stockholm lecture 46:37.

[42] David Albert, “On the Origin of Everything,” critical notice of A Universe from Nothing by Lawrence Krauss, New York Times Sunday Book Review, March 23, 2012.

[43] Alexander Vilenkin to Alan Guth, March 20, 2017. I am grateful to Daniel Came for sharing with me this correspondence, in which Vilenkin strongly rejects Guth’s claim of a beginningless universe on the basis of time-reversal models.

[44] Vilenkin, “The Beginning of the Universe.”

[45] From our debate posted at http://www.reasonablefaith.org/debate-transcript-what-is-the-evidence-for-against-the-existence-of-god#_ftn5; cf. Peter Atkins, Creation Revisited (New York: W. H. Freeman, 1992).

[46] Christopher Isham, “Quantum Cosmology and the Origin of the Universe,” lecture presented at the conference “Cosmos and Creation,” Cambridge University, 14 July 1994.

[47] Sean Carroll, “Does the Universe Need God?” in The Blackwell Companion to Science and Christianity, ed. J. B. Stump and Alan G. Padgett (Oxford: Wiley-Blackwell, 2012), p. 196.