Has the Multiverse Replaced God

William Lane Craig

SUMMARY

For many thinkers, the multiverse has become a sort of God-substitute, serving to explain the creation and fine-tuning of our cosmos. Dr. Craig explains why the multiverse fails as a surrogate deity.

HAS THE MULTIVERSE REPLACED GOD

Several years ago I spoke with Robin Collins, a Christian philosopher who specializes in cosmology, just after his return from a conference on science and theology sponsored by the John Templeton Foundation. "Bill," he said to me, "When these scientists talk about the multiverse, that's actually their way of talking about theology! It's their way of doing metaphysics without using the G--word!"

Indeed, I suspect for many in our contemporary culture the multiverse serves as a sort of God surrogate. The multiverse serves the role of a creator and designer of the universe. It explains why the universe came into being and why the universe is fine-tuned for the existence of intelligent, interactive life. It is thus a sort of substitute deity.

What is the multiverse? The term comes from inflationary cosmology, which is often employed to defend the view that our universe is but one domain (or "pocket universe") within a vastly larger universe, or multiverse. In an attempt to explain the astonishing large-scale smoothness of the universe, certain theorists proposed that a split second after the Big Bang singularity, the universe underwent a phase of super-rapid, or inflationary, expansion which served to push the inhomogeneities out beyond our event horizon. According to inflationary theory, our universe exists in a true vacuum state with an energy density that is nearly zero. But some theorists hypothesize that it is just a bubble of true vacuum in a wider 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 (Fig. 1).

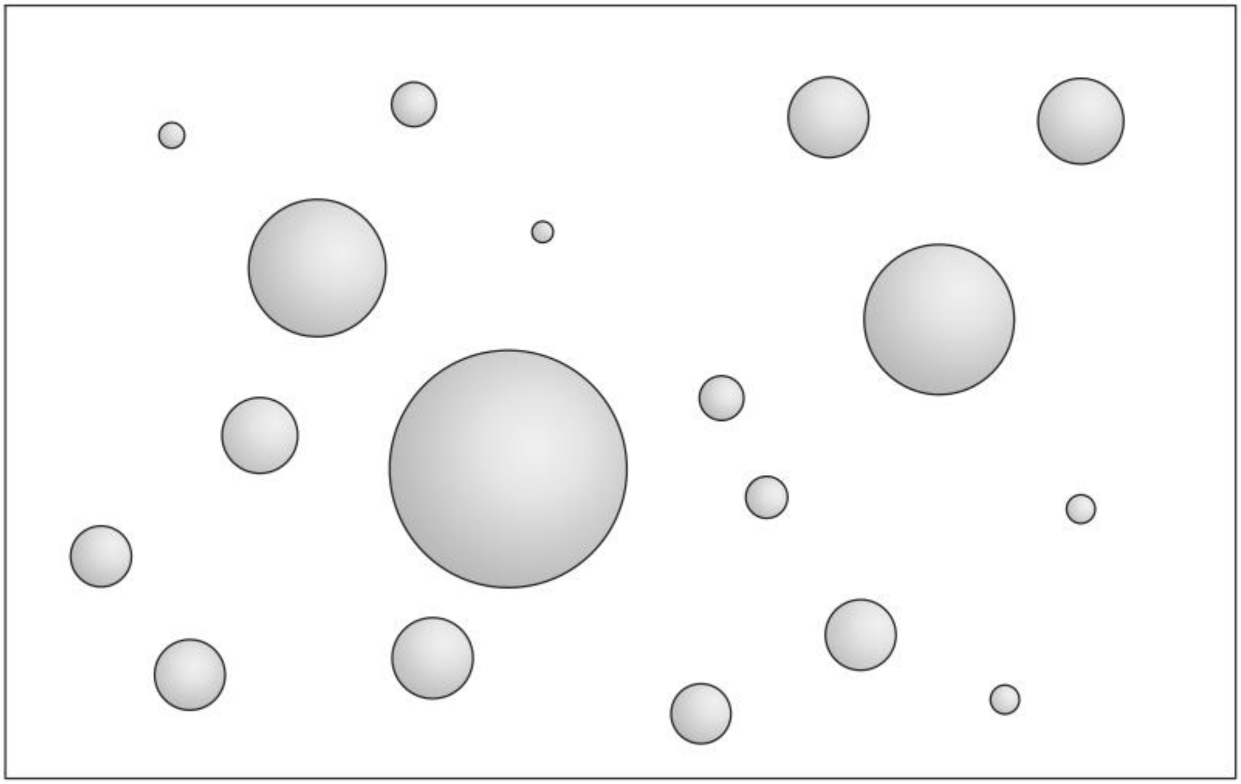

Fig. 1. Bubbles of true vacuum in a sea of false vacuum. As the inflating false vacuum decays, bubbles of true vacuum form in the false vacuum, each constituting an expanding universe. Though rapidly expanding, the bubbles will not coalesce because the false vacuum continues to expand at an even more rapid rate.

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. The wider, encompassing false vacuum filled with these bubbles is referred to as the multiverse. 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 space between the bubble universes and become themselves isolated worlds. Our expanding universe is but one of an indefinite number of mini-universes conceived within the womb of the greater Mother Universe.

Now, of course, the existence of a multiverse is not inconsistent with theism. God could have created a multiverse if he wanted to. Indeed, I think we'll see that the best hope of those who want to believe in the multiverse is theism. The best bet for thinking that a multiverse exists is if God exists.

But does belief in a multiverse render God unnecessary? Now in one sense the answer is obviously not. A multiverse does not provide a foundation for objective moral values or love you or save you from sin. But the claim is that the multiverse renders God unnecessary with respect to the creation and design of the universe. So the multiverse is significant as a defeater for cosmological and teleological arguments for God's existence. The question is whether the natural theologian can make a case for God as the creator and designer of the universe in the face of the multiverse hypothesis.

Cosmological Argument

Let's talk first about arguments for God as the creator of the universe. One version of the cosmological argument attempts to prove that God brought the universe into being at some time in the finite past. The *kalam* cosmological argument originated in the attempts of Christian thinkers to rebut Aristotle's doctrine of the eternity of the universe and was developed by medieval Islamic theologians into an argument for the existence of God. [1] Let's look at the formulation of this argument by al-Gha-zalı- (1058-1111). He reasons, "Every being which begins has a cause for its beginning; now the world is a being which begins; therefore, it possesses a cause for its beginning." [2]

We can summarize Ghazali's reasoning in three simple steps:

1. Whatever begins to exist has a cause.

2. The universe began to exist.

3. Therefore, the universe has a cause.

During the middle ages, before the birth of modern science, people had no scientific evidence for the beginning of the universe. Ghazali presented ingenious philosophical arguments for why the past had to be finite. During the 20th century with Albert Einstein's discovery of the general theory of relativity and its application to cosmology dramatic empirical evidence surfaced for the beginning of the universe.

The empirical evidence for the beginning of the universe comes from what is undoubtedly one of the most exciting and rapidly developing fields of science today: astronomy and astrophysics. Prior to the 1920s, scientists had always assumed that the universe was stationary and eternal. Tremors of the impending earthquake that would topple this traditional cosmology were first felt in 1917, when Albert Einstein made a cosmological application of his newly discovered gravitational theory, the General Theory of Relativity. To his chagrin, Einstein found that the General theory would not permit an eternal, static model of the universe unless he fudged the equations in order to offset the gravitational effect of matter. As a result, Einstein's universe was balanced on a razor's edge, 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 his equations which predicted an expanding universe.

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." [3] 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 showed that the light from distant galaxies is systematically shifted toward the red end of the spectrum. This red-shift was taken to be a Doppler effect indicating that the light sources were receding in the line of sight. Incredibly, what Hubble had discovered was the expansion of the universe predicted by Friedman and Lemaître on the basis of Einstein's General theory. It was a veritable turning point in the history of science. John Wheeler exclaims, "Of all the great predictions that science has ever made over the centuries, 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?" [4]

According to the Friedman-Lemaître model, as time proceeds, the distances separating the galaxies become greater. It's important to appreciate that the model does not describe the expansion of the material content of the universe into a pre-existing, empty space, but rather the expansion of space itself. The galaxies 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 will 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. [5]

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 out of nothing. For not only all matter and energy, but space and time themselves come into being at the initial cosmological singularity. As physicists 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*.” [6] Thus, we may graphically represent space-time as a cone (Fig. 2).

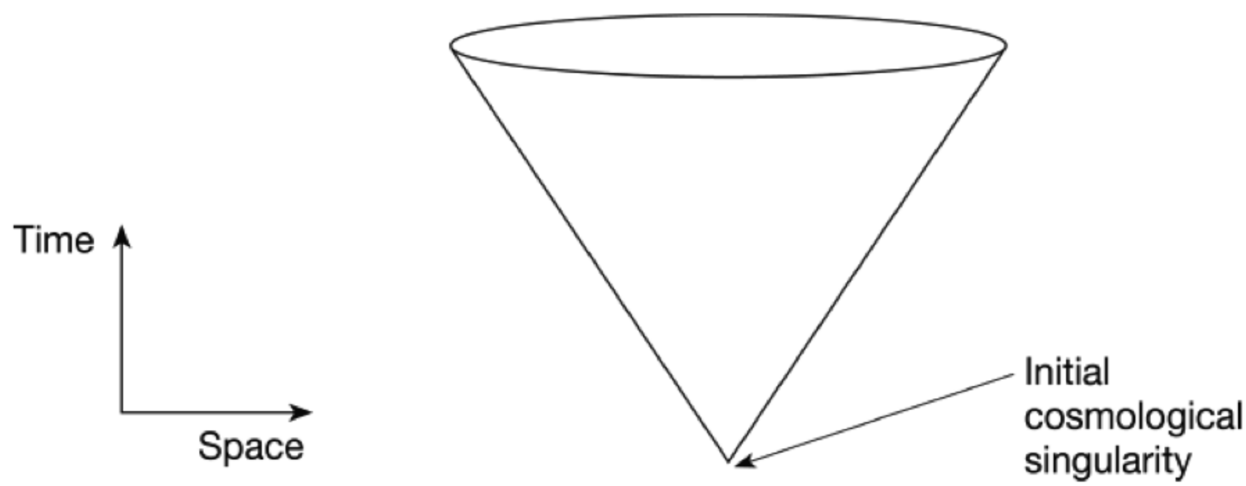

Fig. 2: Conical Representation of Standard Model Space-Time. Space and time begin at the initial cosmological singularity, before which literally nothing exists.

On such a 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.*

Now such a conclusion is profoundly disturbing for anyone who ponders it. For the question cannot be suppressed: *Why did the universe come into being?* Sir Arthur Eddington, contemplating the beginning of the universe, opined that the expansion of the universe was so preposterous and incredible that “I feel almost an indignation that anyone should believe in it —except myself.” [7] He finally felt forced to conclude, “The beginning seems to present insuperable difficulties unless we agree to look on it as frankly supernatural.” [8] The problem of the origin of the universe, in the words of one astrophysical team, thus “involves a certain metaphysical aspect which may be either appealing or revolting.” [9]

Revolted by the metaphysical implications of the standard model, some theorists have sought to formulate nonstandard models to avoid the beginning of the universe. The postulation of a multiverse is one of the most celebrated. The Russian cosmologist Andrei Linde has championed the idea that inflation is future eternal. That is to say, in Linde’s model inflation *never* ends: each inflating bubble of the universe when it reaches a certain volume gives rise via inflation to another domain, and so on, *ad infinitum.* Linde’s model thus has an infinite future.

But Linde is troubled at the prospect of an absolute beginning. He writes, “The most difficult aspect of this problem is not the existence of the singularity itself, but the question of what was *before* the singularity . . . This problem lies somewhere at the boundary between physics and metaphysics.” [10] Linde therefore proposed that inflation is not only endless, but beginningless. Every domain in the universe is the product of inflation in another domain, so that the singularity is averted and with it as well the question of what came before (or, more accurately, what caused it). Our observable universe turns out to be but one bubble in a wider, eternal multiverse of worlds. Thus, the eternal, uncaused multiverse is the creator of our universe.

In 1994, however, Arvind Borde and Alexander Vilenkin showed that any spacetime eternally inflating toward the future cannot be “geodesically complete” in the past, that is to say, there must have existed at some point in the indefinite past an initial singularity. Hence, the multiverse scenario cannot be past eternal. They write,

A model in which the inflationary phase has no end . . . naturally leads to this question: Can this model also be extended to the infinite past, avoiding in this way the problem of the initial singularity?

. . . this is in fact not possible in future-eternal inflationary spacetimes as long as they obey some reasonable physical conditions: such models must necessarily possess initial singularities.

. . . the fact that inflationary spacetimes are past incomplete forces one to address the question of what, if anything, came before. [11]

In response, Linde concurred with the conclusion of Borde and Vilenkin: there must have been a Big Bang singularity at some point in the past. [12]

In 2003 Borde and Vilenkin in co-operation with Alan Guth, the father of inflationary cosmology, were able to strengthen their conclusion by crafting a new theorem independent of the assumption of the so-called “weak energy condition,” which partisans of past-eternal inflation might have denied in an effort to save their theory. [13] The new theorem, in Vilenkin's words, "appears to close that door completely." [14] The Borde-Guth-Vilenkin theorem proves that classical space-time, 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 just is the beginning of the universe. If there was something on the other side, then it will be a 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. Either way, the universe began to exist.

In 2012 in Cambridge at a conference celebrating the 70th birthday of Stephen Hawking, Vilenkin delivered a paper which surveys current cosmology with respect to the question, "Did the Universe Have a Beginning?" He argued that "none of these scenarios can actually be past-eternal." [15] He concluded, "All the evidence we have says that the universe had a beginning." [16] Now that's a remarkable statement. Vilenkin does not say merely that the evidence for a beginning outweighs the evidence against a beginning. Rather he says that all the evidence we have says that the universe has a beginning. Vilenkin pulls no punches:

It is said that an argument is what convinces reasonable men and a proof is what it takes to convince even an unreasonable man. With the proof now in place, cosmologists can no longer hide behind the possibility of a past-eternal universe. There is no escape, they have to face the problem of a cosmic beginning. [17]

Thus multiverse models, like their predecessors, fail to avert the beginning predicted by the Standard Model. Far from eliminating the need for a creator, the multiverse itself requires a creator to bring it into being.

Teleological Argument

But what about the need for the designer of the universe? Perhaps the oldest and most popular of all the arguments for the existence of God is the teleological argument. The ancient Greek philosophers were impressed with the order that pervades the cosmos, and many of them ascribed that order to the work of an intelligent mind who fashioned the universe. The heavens in constant revolution across the sky were especially awesome to the ancients. Plato's Academy lavished extensive time and thought on the study of astronomy because, Plato believed, it was the science that would awaken man to his divine destiny. According to Plato, there are two things that "lead men to believe in the gods": the argument based on the soul, and the argument "from the order of the motion of the stars, and of all things under the dominion of the mind which ordered the universe." [18] Plato employed both of these arguments to refute atheism and concluded that there must be a "best soul" who is the "maker and father of all," the "King," who ordered the primordial chaos into the rational cosmos we observe today. [19]

Thought to have been demolished by the critiques of Hume and Kant, the teleological argument for God's existence has come roaring back into prominence in recent years. The scientific community has been stunned by its discovery of how complex and sensitive a nexus of initial conditions must be given in order for the universe even to permit the origin and evolution of intelligent life. Undoubtedly, it is this discovery which has most served to re-open the books on the teleological argument. The discovery of the cosmic fine-tuning for intelligent life has led many scientists to conclude that such a delicate balance of physical constants and quantities as is requisite for life cannot be dismissed as mere coincidence but cries out for some sort of explanation.

What is meant by "fine-tuning"? The physical laws of nature, when given mathematical expression, contain various constants (such as the gravitational constant) whose values are not determined by the laws themselves; a universe governed by such laws might be characterized by any of a wide range of values for these constants. In addition to these constants, moreover, there are certain arbitrary physical quantities, such as the entropy level, which are simply put into the universe as boundary conditions on which the laws of nature operate. They are therefore also independent of the laws. By "fine-tuning" one means that small deviations from the actual values of the constants and quantities in question would render the universe life-prohibiting or, alternatively, that the range of life-permitting values is exquisitely narrow in comparison with the range of assumable values.

In a sense more easy to discern than to articulate this fine-tuning of the universe seems to manifest the presence of a designing intelligence. The inference to design is best thought of, not as an instance of reasoning by analogy (as it is often portrayed), but as a case of inference to the best explanation. [20] The key to detecting design is to eliminate the competing explanations of physical necessity and chance. Accordingly, a teleological argument appealing to cosmic fine-tuning might be formulated as follows:

1. The fine-tuning of the universe is due to either physical necessity, chance, or design.

2. It is not due to physical necessity or chance.

3. Therefore, it is due to design.

Consider first the hypothesis of physical necessity. A few years ago Stephen Hawking addressed this question at a cosmology conference at the University of California, Davis. Notice the alternative answers which he identifies to the question he poses:

Does string theory, or M theory, predict the distinctive features of our universe, like a spatially flat four dimensional expanding universe with small fluctuations, and the standard model of particle physics? Most physicists would rather believe string theory uniquely predicts the universe, than the alternatives. These are that the initial state of the universe, is prescribed by an outside agency, code named God. Or that there are many universes, and our universe is picked out by the anthropic principle. [21]

These represent precisely the three alternatives laid out in premiss (1). Hawking argues that the first alternative, physical necessity, is a vain hope: “M theory cannot predict the parameters of the standard model. Obviously, the values of the parameters we measure must be compatible with the development of life. . . . But within the anthropically allowed range, the parameters can have any values. So much for string theory predicting the fine structure constant.” He wrapped up by saying,

even when we understand the ultimate theory, it won’t tell us much about how the universe began. It cannot predict the dimensions of spacetime, the gauge group, or other parameters of the low energy effective theory. . . . It won’t determine how this energy is divided between conventional matter, and a cosmological constant, or quintessence. . . . So to come back to the question. . . Does string theory predict the state of the universe? The answer is that it does not. It allows a vast landscape of possible universes, in which we occupy an anthropically permitted location.

In fact, this idea of a “cosmic landscape” predicted by string theory has become something of a phenom in its own right. [22] It turns out that string theory allows around 10^{500} different universes governed by the present laws of nature, so that the theory does not at all render the observed values of the constants and quantities physically necessary. Moreover, even though there may be a huge number of possible universes lying within the life-permitting region of the cosmic landscape, nevertheless that life-permitting region will be unfathomably tiny compared to the entire landscape, so that a randomly thrown dart would have no meaningful chance of striking a life-permitting universe.

What, then, of the alternative of chance? Some theorists have tried to support the chance hypothesis by appeal to the so-called Anthropic Principle. As formulated by Barrow and Tipler, the Anthropic Principle states that any observed properties of the universe which may at first appear astonishingly improbable can only be seen in their true perspective after we have accounted for the fact that certain properties could never be observed by us, since we can only observe properties which are compatible with our own existence. The Anthropic Principle can only legitimately be employed, however, in conjunction with a Many Worlds Hypothesis, according to which a World Ensemble of concrete universes exists, actualizing a wide range of possibilities. The Many Worlds Hypothesis is essentially an effort on the part of partisans of the chance hypothesis to multiply their probabilistic resources in order to reduce the improbability of the occurrence of fine-tuning.

Now if the Many Worlds Hypothesis is to commend itself as a plausible hypothesis, then some plausible mechanism for generating the many worlds needs to be identified. This is where the multiverse enters the picture. Inflation will generate the many worlds which are necessary for the self-selection effect of the anthropic principle to come into play.

Now one problem for the multiverse explanation is that, as we have seen, the BGV theorem requires that the multiverse be finite in the past and have a beginning. Since the Borde-Guth-Vilenkin theorem requires that the multiverse itself cannot be extended into the infinite past, there can be only as many bubble universes now in existence as have formed in the false vacuum since the multiverse's inception at its boundary in the finite past. Given the incomprehensible improbability of the constants' and quantities' all falling randomly into the life-permitting range, it may well be highly improbable that a life-permitting universe should have decayed this soon out of the false vacuum. In that case the sting of fine-tuning has not been removed.

Moreover the multiverse had better not require fine-tuning itself in order to generate the many worlds, otherwise the fine-tuning problem has not been eliminated but just kicked upstairs. The whole multiverse scenario depends on the hypothesis of future-eternal inflation, which in turn is based upon the existence of certain primordial scalar fields which govern inflation. Although Vilenkin observes that "Inflation is eternal in practically all models suggested so far," [23] he also admits, "Another important question is whether or not such scalar fields really exist in nature. Unfortunately, we don't know. There is no direct evidence for their existence." [24] This lack of evidence ought to temper the confidence with which the Many Worlds Hypothesis is put forward.

Wholly apart from its speculative nature, however, the Many Worlds Hypothesis faces a potentially lethal problem. Simply stated, if our universe is but one member of an infinite World Ensemble of randomly varying universes, then it is overwhelmingly more probable that we should be observing a much different universe than that which we in fact observe. Roger Penrose calculates that the odds of our universe's low entropy condition obtaining by chance alone are on the order of $1:10^{10(123)}$, an inconceivable number. [25] The probability that our solar system should suddenly form by the random collision of particles is $1:10^{10(60)}$. (Penrose calls it "utter chicken feed" by comparison.) Thus, it is inconceivably more probable that our solar system should suddenly form by the random collision of particles than that a finely-tuned universe should exist. So if our universe were just a random member of a World Ensemble, it is inconceivably more probable that we should be observing an island of order no larger than our solar system. For there are far more observable universes in the World Ensemble in which our solar system comes to be instantaneously through the accidental collision of particles than universes which are finely-tuned for intelligent life. Indeed, the most probable observable universe is one in which a single brain fluctuates into existence out of the quantum vacuum and observes its otherwise empty world. Observable universes like those are just much more plenteous in the World Ensemble than worlds like ours and, therefore, ought to be observed by us. Since we do not have such observations, that fact strongly disconfirms the multiverse hypothesis. On atheism, at least, it is therefore highly probable that there is no World Ensemble. Since the alternative of chance stands or falls with the Many Worlds Hypothesis, that explanation is seen to be very implausible.

It therefore seems that the fine-tuning of the universe is plausibly due neither to physical necessity nor to chance. It follows that the fine-tuning is therefore due to design. For that reason, as I said earlier, the best hope for the multiverse hypothesis is theism: God could have created a World Ensemble brimming with deliberately finely tuned worlds.

Conclusion

In conclusion the multiverse hypothesis does nothing to eliminate the need for a creator and designer of the universe. Whether or not a multiverse exists, one needs a transcendent, personal creator and designer of the cosmos.

Footnotes

[1]

"*Kala-m*" is the Arabic word for speech and came to denote a statement of theological doctrine and ultimately the whole movement of medieval Islamic theology.

[2]

Al-Gha-zalı-, *Kitab al-Iqtisad fi'l-I'tiqad*, cited in S. de Beaurecueil, "Gazzali et S. Thomas d'Aquin: Essai sur la preuve de l'existence de Dieu proposée dans l'Iqtisad et sa comparaison avec les 'voies' Thomiste," *Bulletin de l'Institut Francais d'Archaeologie Orientale* 46 (1947): 203.

[3]

Gregory L. Naber, *Spacetime and Singularities: an Introduction* (Cambridge: Cambridge University Press, 1988), pp. 126-27.

[4]

John A. Wheeler, "Beyond the Hole," in *Some Strangeness in the Proportion,* ed. Harry Woolf (Reading, Mass.: Addison-Wesley, 1980), p. 354.

[5]

P. C. W. Davies, "Spacetime Singularities in Cosmology," in *The Study of Time III,* ed. J. T. Fraser (Berlin: Springer Verlag, 1978), pp. 78-9.

[6]

John Barrow and Frank Tipler, *The Anthropic Cosmological Principle* (Oxford: Clarendon Press, 1986), p. 442.

[7]

Arthur Eddington, *The Expanding Universe* (New York: Macmillan, 1933), p. 124.

[8]

Ibid., p. 178.

[9]

Hubert Reeves, Jean Audouze, William A. Fowler, and David N. Schramm, “On the Origin of Light Elements,” *Astrophysical Journal* 179 (1973): 912.

[10]

Linde, “Inflationary Universe,” p. 976.

[11]

Borde and A. Vilenkin, “Eternal Inflation and the Initial Singularity,” *Physical Review Letters* 72 (1994): 3305, 3307.

[12]

Andrei Linde, Dmitri Linde, and Arthur Mezhlumian, “From the Big Bang Theory to the Theory of a Stationary Universe,” *Physical Review D* 49 (1994): 1783-1826. Linde has since tried to suggest a way to escape the conclusion of a beginning (“Inflation and String Cosmology,” arXiv:hep-th/0503195v1 (24 Mar 2005), p. 13. But he does not succeed in extending past spacetime paths to infinity, which is a necessary condition of the universe’s having no beginning.

[13]

Arvind Borde, Alan Guth, and Alexander Vilenkin, “Inflation Is Not Past-Eternal,” http://arXiv:gr-qc/0110012v1 (1 Oct 2001): 4. The article was updated in January 2003.

[14]

Alexander Vilenkin, “Quantum Cosmology and Eternal Inflation,” http://arXiv:gr-qc/0204061v1 (18 April 2002): 10.

[15]

Audrey Mithani and Alexander Vilenkin, “Did the universe have a beginning?” ArXiv 1204.4658v1 [hep-th] 20 April 2012. *Cf*. his statement “There are no models at this time that provide a satisfactory model for a universe without a beginning” (A. Vilenkin, “Did the Universe Have a Beginning?” lecture at Cambridge University, 2012). Specifically, Vilenkin closed the door on three models attempting to avert the implication of his theorem: eternal inflation, a cyclic universe, and an “emergent” universe which exists for eternity as a static seed before expanding.

[16]

Lisa Grossman, “Why physicists can't avoid a creation event,” *New Scientist* 11 January 2012.

[17]

Alex Vilenkin, *Many Worlds in One: The Search for Other Universes* (New York: Hill and Wang, 2006), p. 176.

[18]

Plato, Laws 12.966e.

[19]

Plato, Laws 10.893b-899c; idem *Timaeus.*

[20]

See Peter Lipton, *Inference to the Best Explanation* (London: Routledge, 1991).

[21]

S. W. Hawking, “Cosmology from the Top Down,” paper presented at the Davis Cosmic Inflation Meeting, U. C. Davis, May 29, 2003.

[22]

See Leonard Susskind, *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design* (New York: Little, Brown, & Co., 2006). Susskind apparently believes that the discovery of the cosmic landscape undercuts the argument for design, when in fact precisely the opposite is true. Susskind doesn't seem to appreciate that the 10^{500} worlds in the cosmic landscape are not real but merely possible universes consistent with M-Theory. To find purchase for the anthropic principle mentioned by Hawking as the third alternative, one needs a plurality of real universes, which string theory alone does not provide.

[23]

Vilenkin, *Many Worlds in One,* p. 214.

[24]

Ibid., p. 61.

[25]

Roger Penrose, *The Road to Reality* (New York: Alfred A. Knopf, 2005), pp. 762-5. Penrose concludes that anthropic explanations are so "impotent" that it is actually "misconceived" to appeal to them to explain the special features of the universe.