Inconstant Multiverse

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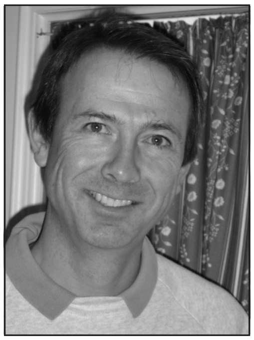

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Explaining why there is something rather than nothing is one of theology's primary tasks. Recent scientific findings in cosmology have suggested a new theological task: explaining why there is something rather than everything. This task arises because of the conjunction of two intriguing properties of our universe: its strong biophilic selection effects and its apparent causal-connectedness on its largest scales. Current explanatory paradigms—respectively the anthropic principle and the inflationary universe—have suggested to many that our observable universe is a small part of a much larger structure called the multiverse. A multiverse presents us with a containment problem, since its logical extension suggests that anything that can exist, does exist. I argue such a perspective is incompatible with the foundations of both science and theology. As an antidote, I propose the altiverse: a set of possible alternatives that logically exist but are not physically realized.

Explaining reality in teleological terms is a common feature shared by all forms of theological inquiry, both Eastern and Western.

One of the most longstanding and perplexing questions that humanity has ever wrestled with is the problem of existence: why is there something rather than nothing? It is a challenge that has eluded philosophers and scientists alike, as it would seem to be a necessary condition for all other forms of rational inquiry to take place. Yet, at the same time, while it is not impossible to imagine a state of nothingness, it is difficult to understand why this is not the natural state of affairs.

It is here that theological forms of inquiry make certain inroads. Rather than accepting the existence of things *prima facie* and then proceeding from there, theology seeks to understand the origin of existence. Indeed, the task of explaining why anything exists at all is generally regarded as one of theology's root tasks. The core hypothesis underlying such inquiry is generally teleological in character: namely, that there is an underlying purpose behind the existence of all things.

Explaining reality in teleological terms is a common feature shared by all forms of theological inquiry, both Eastern and Western. In both cases, the telic approach has both immanent and transcendent aspects. The immanent aspects are concerned with human behavior in the here and now. What is the most fruitful means for navigating the self through one's natural and social environment? What is the appropriate relationship between the individual and the community? More generally, given the framework of existence, how should one live? The answers to these and other like questions take distinct forms among the different world religions (and even within a given religion). However their common feature is that of understanding and resolving such issues in a telic context.

The transcendent aspects of telic explanations of reality are concerned with broader questions that go well beyond the concerns of particular individuals or communities. Here one is concerned with why the framework of existence is what it is. Eastern religions generally adopt the view that there is an ultimate reality behind all extant things, and that our perception of this ultimate reality is obscured or distorted to varying degrees by the superficial aspects of our everyday experience and our natural environment. Western religions generally ascribe this ultimate reality to God, and work from the hypothesis that things exist because a Creator intended them to be so. The basic idea of God is that of some (infinitely) superior being creating time and space, matter and energy, and order from chaos, ulti-

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mately for some purpose. The Creator transcends the creation, distinct from it to varying extents. Extreme Deism takes the perspective that the Creator's only relationship to the creation is that of initiating its existence. In contrast to this, the Christian God becomes intimately involved with creation and with the created beings within it, so much so that the transcendent God is also the immanent Holy Spirit, who at one particular period in history coalesces into the person Jesus Christ.[1]

The symbiotic relationship between Christian notions of immanence and transcendence resonate across the various world religions. An understanding of one has implications for the other. Theological reflection as to how one should live in this world naturally leads to questions as to why this world is the way that it is. Conversely, contemplation of the grand panoply of existence leads naturally to questions of what one's purpose is within the larger world stage. The yin and yang of immanent and transcendent understandings of reality are encircled by a telic thread. Neither can be understood outside of a telic framework. To reiterate, a salient characteristic of a theological explanation is that it is teleological in essence: things exist because there is some purpose or intent that caused them to be.

There are many that find this form of explanation quite unsatisfactory. The common objection generally takes the form of a question: "If God created everything, what created God?" More sophisticated forms of theology furnish an answer to this question that takes on the following general form: God is understood to have a qualitatively different character from other existing things, and is, in some sense, self-created by definition.[2] While skeptics might acknowledge this philosophical possibility, many nevertheless remain discomforted. Simply put, they seek some kind of evidence to support a telic understanding of the "why something instead of nothing" question.

Biophilic Selection Effects

Recent work in physics and cosmology has provided no small amount of indirect support for the theological explanation. This is because of the mounting evidence that we inhabit a biophilic universe: one whose properties admit the existence of life as we know it.[3] Of course, it is obvious that we could not inhabit a universe that was hostile to life. However it has become clear that the necessary conditions for life to exist depend upon very special physical circumstances. Specifically the constants of nature—the speed of light, the relative strengths of the forces, the masses of the various subatomic particles—are intimately linked to the existence of life. A hypothetical universe in which these constants took on numerical values that differed only a very small amount from the values measured in the laboratory would be a biophobic universe: it would not harbor any physical systems that could support life as we know it. Examples abound that illustrate the point: modify only slightly just one of the constants of nature, and one finds that the resultant laws of physics would not permit any stable atoms heavier than hydrogen, or not admit stable planetary systems to form around stars, or render the carbon nucleus unstable, or precipitate some other life-stopping situation.[4]

This recently appreciated observed state of affairs provides partial empirical support for a telic explanation of existence. Out of all possible universes that one could imagine generating by changing the constants of nature, a biophilic universe can be obtained only by making a very particular choice of these constants. This is a very strong selection effect. It is not unreasonable to entertain the possibility that a superintelligence governs this selective state of affairs, and that this "fine tuning" of the constants of nature is by intent as opposed to accident. Conversely, the alternate situation—namely that biophilic universes are possible for a broad range of choices on physical constants—would undermine a telic explanation.

The primary reason underlying much of the skepticism behind theology's response to the problem of existence is that it is a telic form of explanation as opposed to an ecbatic one.

Much of the discourse today in science and religion has to do with these biophilic selection effects. It has been argued in many different contexts that such selection effects (often referred to as the anthropic principle) are best understood in a theological framework, one that purports they signify actual choices made by a Creator that desired a universe containing (sentient) life. The intriguing relationships between the masses of the subatomic particles, the strengths of the various forces of nature, and so on, are what they are, it is argued, because of the purposeful intent of a Designer.[5] To use the words of Paul Davies, they suggest in very strong terms that there is indeed "something behind it all."[6]

It is clear, however, that such a perspective has not met with universal approval. The primary reason underlying much of the skepticism behind theology's response to the problem of existence is that it is a telic form of explanation as opposed to an ecbatic one. The word ecbatic derives from the Greek word *ekbatos*, signifying result without intention. An ecbatic process, then, is one that follows a natural course of action. This is in contrast to the notion of *telos*, or purpose, from which the adjective telic is derived.

[Scientific explanations] seek to describe nature—and perhaps all of reality—in terms that do not rely on a concept of purpose. … This ecbatic approach toward understanding reality—often referred to as naturalism—has enjoyed enormous success since its inception during the enlightenment.

The flow of water over a waterfall is an ecbatic process, whereas the flow of water through an aqueduct is a telic process. If an action is rendered "so that it was fulfilled" then it is ecbatic; if rendered "in order that it might be" then it is telic.

Scientific explanations are generally ecbatic in character. They seek to describe nature—and perhaps all of reality—in terms that do not rely on a concept of purpose. Rather than understand the phenomenon of thunder in terms of the displeasure of certain deities, a scientific explanation would seek understanding in terms of the motion of air masses and the charge separation of the various particles within them. This ecbatic approach toward understanding reality—often referred to as naturalism—has enjoyed enormous success since its inception during the enlightenment. There is no doubt that it has transformed virtually every aspect of modern life, including communications, medicine, transportation, manufacturing, and recreation.

This strong measure of empirical success gives one good reason to revisit the question of existence. From an ecbatic perspective, rather than explain the "something instead of nothing" conundrum in terms of purpose and relationship, one seeks instead an explanation in terms of an impersonal causal chain of events. Faced with the strong biophilic selection effects noted above, an ecbatic explanation of existence must rely on additional philosophical input. It is here that the multiverse enters the scene.

Consider first that not all selection effects have a telic origin. Nontelic selection effects in any system can have one of two explanations: necessity or chance. If the selection effects are governed by necessity, it means that there is some operative underlying physical law that obstructs certain situations from occurring that would otherwise be admissible. For example, the observation that the total amount of electric charge never varies in any closed physical system is explained by the necessity of the conservation of charge from the underlying physical laws of electricity and magnetism (as opposed to a fortuitous situation in which the charge is always balanced). If the selection effects are governed by chance, then different considerations come into play.

Governance by chance means that there have been many similar replications of the system in question (either in time, in space, or both) that are consistent with the physical laws that describe it. If the replications are identical to each other, then of course nothing is gained in terms of understanding why a given system might have special characteristics (the selection effects). However if the replications differ slightly from one another, then eventually (again, either in time or space or both) all possible configurations of the system will be realized. Hence one can employ probabilistic arguments to explain the observation of a system with certain special features: since the replication process ensures that all (or nearly all) configurations are realized, then configurations with special features must also be realized, and the observer was simply fortunate in observing such features. In other words, the particular observed features of a given system are present simply because one is bound to get lucky after many repeated attempts. For example, it is no surprise that a lottery has a winner: out of the many similar tickets sold, one of them must be the winning ticket.

This approach is commonly applied in the scientific method. In subatomic physics experiments, the billions and billions of events recorded in particle collisions ensure that rare and unusual processes will be seen. In biology, patient observation within the natural habitat of a given species ensures that eventually its unusual characteristics (e.g., a mating ritual) will be seen.

Ecbatic explanations must rely on either necessity and/or chance to explain selection effects in any system. To the extent the explanation relies upon necessity, it means that out of all the possible configurations of a system that one could contemplate, only certain particular configurations are observed due to some underlying physical law or principle. To the extent the explanation relies upon chance, it means that the observed particular configurations are the result of a statistical anomaly that could occur from many similar replications of the system. In contrast to this, a telic explanation of a selection effect posits that the observed particular configurations are the result of an intelligent agent making deliberate choices within the constraints of the system; a different agent (or the same agent with different intentions) would make a different choice, yielding different particular configurations.

Ecbatic Explanations of Biophilic Selection

In order to explain the selective biophilic features of our universe via necessity, one would have to construct a physical theory that is logically and mathematically self-consistent only when its constants of nature take on the values we observe. While it is difficult to fully rule out such a possibility, there have been no compelling forthcoming physical theories that have had such a feature. Indeed, most physical theories that have been constructed (or even contemplated) are logically self-consistent regardless of the empirical values of the fundamental constants. However there is some hope that perhaps a fully unified theory of everything (i.e., of all forces and particles) will explain these empirical values from mathematical first principles. Proponents of string theory have long argued that this is one of many tantalizing possibilities that string theory offers.[7] String theory aspires to be the root fundamental theory of physics from which all other physical theories are derived. An expectation of such a fundamental theory is that it be able to explain the observed values of the constants of nature, including the masses of all particles and the strengths of the forces that govern their interactions.

What we traditionally refer to as the universe is more properly referred to as the observed universe, and that it is a small part of a much larger structure known as the multiverse.

Should an explanation by necessity of the fundamental constants of nature prove successful, it would be a remarkable result. It would almost certainly undermine a telic explanation for the observed cosmic biophilic selection effects, though it is not inconceivable that such an explanation would point to a deep telic understanding of nature. At the very least the telic explanations of biophilic selection effects would have to be revisited.[8] However, a necessary explanation for the observed constants of nature is nowhere in sight at this point in the history of theoretical physics.

It is therefore reasonable to entertain a chance explanation of biophilic selection. This can be done by invoking the concept of the multiverse.[9] The idea here is that what we traditionally refer to as the universe is more properly referred to as the *observed universe*, and that it is a small part of a much larger structure known as the multiverse. By definition, the multiverse contains many similar replicants of the observed universe, with each universe differing slightly from the others in small but quantitatively distinct ways. In the context of the biophilic selection effects noted above, each universe within the multiverse is hypothesized to differ from its companions by having slightly distinct values of its fundamental constants. The multiverse is thus posited to be an enormously vast collection of universes, each with their own particular values for the strength of the electromagnetic force, the mass of proton, and so on. Like the lucky winner of a lottery, our universe happens to be the special one among its many replicants in which the constants of nature take on just the proper values for life to exist. The other replicants also exist, but they are sterile, with their constants of nature yielding a universe that is devoid of life.

Empirical Support for a Multiverse?

Is there empirical support for the multiverse scenario? This question merits some consideration, since one must first ask what would count as evidence. Almost by definition, multiverse models propose a physical situation in which our observable universe is replicated many times over, either by repeated numbers of big bang scenarios (perhaps via gravitational collapse of a black hole in a pre-existent universe[10]) or by extending the universe over a much larger spatial region than is currently observed (or perhaps both). Whatever the mechanism, in the multiverse scenario, our observable universe is regarded as a tiny domain in a much larger structure. Since it is the *observable* universe that is considered to be a tiny domain, it cannot by definition access the other parts of the much larger multiverse in which it is embedded. There is therefore no experiment or observation that one could perform which would provide direct empirical evidence of the multiverse, though indirect support is not inconceivable.[11]

Consider first a multiverse in which the big bang is repeated many times over, each time followed by a big crunch, or re-collapse of the universe. Here one regards our universe today as simply the current repeat in the bang-crunch cycle. However, since essentially all information from a given universe is destroyed in its big crunch, the universe that is subsequently born afterward is empirically disconnected from its predecessors. One could only infer the existence of such predecessors by finding a specific theoretical model of a bang-crunch cycle that provided the most coherent and compelling correlation with cosmological observation. The attraction of such cyclic models is in their avoidance of issues concerned with initial conditions, a situation decidedly telic in character.

Cyclic models, however, are not without problems. One of these is that a given universe inherits the entropy of its predecessors, increasing the maximal size and duration of a cycle from bang to crunch.[12] Extrapolating backward in time, one encounters a cycle of length zero, leading to an initial condition scenario that undermines the ecbatic motivation for the model. Recent cosmological evidence of type IA supernovae, the cosmic microwave background radiation, and the power spectra of galaxies points away from such a model insofar as our universe is accelerating in its expansion, mitigating against a big crunch sometime in the distant future.[13] While it is not inconceivable that the multiverse could consist of temporal replicants of our universe, it appears unlikely that this is the case (though recently a new model of a cyclic universe has been proposed[14]).

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The other alternative is that of multiverse models that replicate our universe in space. This idea fits in rather nicely with the paradigm of an inflationary universe. The inflationary universe, first proposed nearly twenty-five years ago, was put forward to solve two key cosmological puzzles within standard big bang cosmology (itself extremely successful in correlating the observable properties of our universe). One puzzle is referred to as the horizon problem: how is it possible that the temperature of the cosmic microwave background (now known to be 2.725 K) can have a temperature uniform to better than one part in 30,000? This uniformity holds for widely separated regions of space, so much so that they have never been able to communicate with each other even by influences traveling at light velocity. The boundary of the region beyond which one is unable to receive a signal from some distant source because of the finite speed of light is termed a horizon in cosmology, from which originates the name of this puzzle. In the standard big bang theory, this required level of uniformity must be assumed. The second puzzle is termed the flatness problem: why, in geometrical terms, is the curvature of the universe so small (i.e., so nearly flat, like a tabletop, instead of curved like either a sphere or a saddle)? Einstein's general theory of relativity predicts that this is a very unlikely result of the evolution of the universe from the big bang, unless the initial curvature is confined to an incredibly narrow range of possibilities. Why should this be so?

The inflationary universe paradigm (referred to as "inflation" for short) proposes that all parts of our observable universe were once in causal contact in the very distant past.[15] The matter and energy of the universe therefore can come to a homogeneous thermal equilibrium. After this, about 10^{-35} seconds after the big bang, the universe expands for a fleeting instant at a much higher rate than one would expect (this is due to hypothesized properties of elementary particles not accounted for in the standard big bang model). Gravitation effectively becomes repulsive for a short period, and the average distance between any two points (the scale size) in space grows by a factor of about 10^{50}. Distant regions of the universe are pushed out of causal contact with one another while maintaining the homogeneity of structure and uniformity of temperature. This process ends by some means after about 10^{-32} seconds, after which time it expands according to the standard big bang model. Small scale structures (galaxies and clusters of galaxies) form after this time.

Within the context of inflation, our observable universe that extends 13.7 billion light-years in every direction was once a very tiny structure, no larger than a grapefruit. It is natural to imagine that the spatial extent of the full universe was much larger in size at that time. As a consequence of inflation, all of space has expanded to enormous size, many times larger than our observable universe. We cannot observe these other spatial regions simply because there has not been enough time for light (and any other matter or energy) to travel from these regions into our universe. Indeed, present cosmological data implying an accelerated expansion indicate that the light from these distant regions will never reach us.[16]

The inflationary paradigm thus provides a home for a spatial multiverse. Our observable universe in this context is simply a very tiny region in a vast spatial structure. It is quite conceivable that within this vast spatial structure the mechanism by which inflation begins and/or ends is not constant, but varies from place to place. The multiverse would then be broken up into different spatial domains of varying size, a typical size being much larger than our observable universe. Within each domain, the constants of nature could take on distinct values as a consequence of the different ways that inflation begins and ends. In most of these domains, the set of values inherited are biophobic. However, on probabilistic grounds, there will be some region in which the set of values are biophilic. The only regions of the multiverse that can be recorded by observers are clearly the biophilic regions. The observed empirical values of the constants of nature are thus understood to be the consequence of an ecbatic observational selection effect: namely only those regions of the multiverse that have biophilic values will contain observers.

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Is such a model empirically credible? Recent cosmological data suggest some tantalizing possibilities. Inflation predicts that fluctuations in the primordial density in the early universe have the same amplitude on all physical scales, and that there should be on average equal numbers of hot and cold spots in the fluctuations of the cosmic microwave background temperature.[17] Detailed measurements from the Wilkinson Microwave Anisotropy Probe (WMAP) over the past year have provided us with a great deal of information that quantitatively constrains cosmological paradigms.[18] In particular, the detection of a large-angle anti-correlation in the temperature—polarization cross-power spectrum—is a signature of adiabatic superhorizon fluctuations in the microwave background, consistent with the expectation of the inflationary paradigm.[19] Superhorizon fluctuations are small fluctuations that very rapidly get amplified to become much larger than the observable universe. This does not happen in non-inflationary models (e.g., cosmic strings), where correlations in observed physical quantities cannot be larger than 2°; hence detection of correlations in the microwave background on angular scales larger than 2° provides very strong evidence for the existence of this kind of amplification (and therefore for inflation). The WMAP experiment was able to measure both fluctuations in the temperature (which physically are due to fluctuations in the density of photons) and fluctuations in the polarizations of photons (which physically are due to the spatial distribution of the velocity of the fluid of baryons just prior to the time at which it was cool enough for stable atoms to form). In an inflationary paradigm, both fluctuations are amplified to superhorizon sizes and become anti-correlated over large angular scales—at present there is no non-inflationary model that does the same thing. These anti-correlations have been observed by WMAP.

Implications

Such data, while not providing direct empirical support, suggest that the notion of an actual multiverse must be taken very seriously. While it may never be possible to definitively prove its existence, it is certainly conceivable that in the foreseeable future observational evidence for inflation will become extremely strong, thereby yielding strong circumstantial evidence supporting the notion that our observable universe is a very tiny part of a much larger structure, namely the multiverse. This raises significant challenges for theology, since the ecbatic perspective that the multiverse paradigm places on the origin of the constants of nature undermines a telic understanding of biophilic selection effects. Simply put, if we have empirical support for a compelling ecbatic mechanism for explaining the origin of the constants of nature, why would we adopt a telic approach to this issue?

To rise to this theological challenge is no small task. Telic explanations of a given phenomenon are generally invoked for one or both of two reasons: either there is considerable experience with previous telic mechanisms or there is no rationally compelling ecbatic explanation. For example, the unearthing of a bit of pottery in an archaeological dig is generally understood in a telic context (some person(s) made it) because we have a wealth of experience that pottery is made by human beings. Similarly, we infer that the arrangement of boulders at Stonehenge has a telic explanation (i.e., some group of persons constructed it) not because we have significant past experience, but rather because there is no compelling naturalistic means by which this arrangement could have occurred. This last approach invokes a telic mechanism by default.

Since we have only one observable universe, we cannot rely on experience with previous telic mechanisms to explain it. In the absence of positive indicators for telic processes, we must rely on invoking teleology by default. Given the extraordinary biophilic selection effects noted above, this is quite reasonable provided there is no plausible ecbatic mechanism. We have seen that the most likely ecbatic mechanism relies upon the concept of a multiverse. It has generally been thought there is a neutral choice[20] between the two approaches: the selection effects could either be explained by a superintelligence making a choice among possibilities or by our universe being a small region within a multiverse as described above. However, the recent data from WMAP, to the extent that they confirm inflation, provide indirect empirical support for a multiverse.

The notion of a multiverse is not compatible with the notion of a deity who makes choices that have consequences. … The scientific method has no hope of predicting outcomes based on initial conditions. … The problem with the multiverse [is]: once you start replicating universes, you cannot stop.

Some might like to argue that both options are available: namely, that the multiverse has a Creator. While this perhaps cannot be ruled out on grounds of logic, it seems to me that this case is intellectually pointless. A god who creates a multiverse is a god who creates all possible choices. In other words, whatever can be created is created. However, this is not a god who chooses among a set of possibilities to realize a purpose. Such a god is even less relevant than that proposed by deists. The notion of a multiverse is not compatible with the notion of a deity who makes choices that have consequences.

Indeed, the logical extension of the multiverse scenario suggests that anything that can exist does exist, provided constraints of logical self-consistency are satisfied. The observable region of our universe therefore in this context has the properties that it has simply because all possible alternatives have been physically realized elsewhere (and/or sometime) in the multiverse. We should be no more surprised to observe the special biophilic properties of our universe within the multiverse than we should be to see a 29-hand of cribbage be dealt every so often to players that play the game constantly.

Further reflection on this point indicates a serious problem of intellectual self-consistency with the multiverse scenario. Recall that the purpose of the multiverse is to allow us to regard our universe as a very tiny structure within a much larger setting, so that its special observed properties (the constants of nature) take on their values for probabilistic reasons. Within the vast domains of the multiverse, only very special regions can take on such values. However, one can naturally ask the question: how many regions take on such special values? Clearly the answer must be at least one, since we are here to observe them. But is the answer more than one? And if so, how much more?

Simple inspection indicates that the answer must be more than one. Since each domain of the multiverse takes on values of the fundamental constants of nature in a random way, it is logically possible that more than one domain can have biophilic properties similar to our own. If there is something that obstructs this, the onus is on the ecbatic model to explain why. If nothing obstructs this, then more than one biophilic region is possible. But how many more? If the number is two, then this also merits explanation. Indeed, any finite number of biophilic regions demands an ecbatic explanation as to why only finitely many such regions exist within a multiverse of infinite spatial size. A telic explanation (namely the number of biophilic regions was the choice of a superintelligence) is pointless, as it undermines the original ecbatic motivation of the multiverse.

Further problems abound. If there are infinitely many biophilic regions in the multiverse, then there must be a region whose causal history is nearly identical to that of our own observable universe. This means that there is another region of the multiverse—an unimaginably vast (but finite!) spatial distance away from our own—in which there exists a planet whose physical, biological, and social history is nearly identical to that of our own earth's history. The second "earth" could be duplicated by a third "earth," again almost identical in all aspects of its structure and history. Continuing to draw on the vast resources of mathematical infinity to the point of absurdity, the extension of this model to the extreme suggests that all possible logically consistent alternatives for any physical subsystem have been realized somewhere (and/or sometime) in the multiverse. This includes the activities of each and every living being. For example, I must have written (or will write) this essay countably infinitely many times, with all of its possible variants likewise written.

Such a scenario seems ridiculously absurd, on par with the notion that the entire universe is simply a dream that I am having. It undermines not only the telic foundations of theology, but of scientific reasoning itself. We gain no intellectual profit from such an approach since the scientific method has no hope of predicting outcomes based on initial conditions. Our confidence in the ability of experiment to empirically falsify any scientific model that explains a causal chain of events from A to B is undermined. Not only are the constants and laws of nature environmentally determined (due to our random location in the multiverse) but so are the actual outcomes of any specific event. Experiments, rather than falsifying scientific models that describe one universe, instead become a kind of "weather report" that simply tell us what our corner of the multiverse is like now. An intellectually honest commitment to a multiverse would entail considering all logically admissible ad-hoc scientific models, since we cannot be sure that we are not in a region of the multiverse that is described by such an ad-hoc model. We might just as well invoke a *que sera sera* attitude toward science, since the multiverse allows all possible options.

This then is the problem with the multiverse: once you start replicating universes, you cannot stop. Yet we must stop in order to avoid the absurd (yet logically admissible) conclusions noted above. It is therefore necessary to impose some constraints on the multiverse. Perhaps it is only finite in size and/or duration. Perhaps logic forces only a finite number of biophilic regions to exist.

From an ecbatic perspective, one is then led back to either arguments of necessity or chance. If one is to constrain the multiverse in some way, one must furnish logically compelling (and empirically testable) reasons for doing so. This by no means is a small challenge, particularly if one wishes to avoid both a telic interpretation of the constraints and an undermining of the statistical rationale for biophilic regions that the multiverse is supposed to provide.

Theology's New Question

One is thus led to a new problem for theology: why is there something rather than everything? This challenge is no less daunting than the "something instead of nothing" question. While it might seem initially absurd to contemplate such a question, we have seen that multiverse scenarios naturally lead to this consideration. If theology wishes to retain a telic understanding of our universe, it is just as important to address this question as it is to address the more traditional issue of *creatio ex nihilo*. The god who brings things into existence must also be a god who prevents all possible things from existing.

As a theological antidote to rampant replication of universes, I propose that the observable universe be embedded in an altiverse: a set of possible alternatives that logically exist but are not physically realized. Unlike the multiverse, in which there are many universes that have a physical existence, the altiverse simply encompasses that range of possible alternative states that our single observable universe can evolve into from a given set of initial conditions. Change from one state to another depends on the necessity of physical law, the statistical likelihood of random processes, and on the desires of intelligent agents (natural and supernatural) to achieve particular ends.

This latter assertion—that the desires of intelligent agents play an intrinsic role in the development of the universe (or a small part of it) from one instant to the next—would seem to imply that there are gaps in what would otherwise be a seamless causal picture from physical theory. It is reasonable to ask what supporting evidence there might be for an altiverse with causal gaps. Following are four examples:

1. *Quantum mechanics:* There is a wealth of empirical evidence that we live in a quantum world, one in which a given set of initial conditions can yield a variety of results. Although quantum theory can predict the statistical probabilities over many trials for a replicated set of systems, the actual causal connection between a given initial state and a given final state remains outside the purview of the theory. One could understand an altiverse to be the set of all possible outcomes of a given quantum-mechanical system.

2. *Chaotic phenomena:* It is now generally understood that small changes in initial conditions can yield vastly different physical outcomes for a given system. Although deterministic equations can describe systems that have this property, it is simply not possible to predict the outcome of the evolution of any such system with arbitrary accuracy for arbitrarily long times. One could understand the altiverse to include the vast range of possibilities that a chaotic system could realize.

3. *Conscious will:* Recent experiments have demonstrated that it is possible for mental states to influence material objects.[21] The actual experiments involved the connection of the brains of monkeys to a computer. The monkeys—conditioned by the promise of a reward—learned how to manipulate a joystick so that a dot on the computer could move to intersect another dot. A study of the brain wave patterns of the monkeys during this task allowed the experimenters to develop an algorithm that would manipulate the dot based on the brain wave patterns. Upon connecting their brains to the computer containing the algorithm, the monkeys soon learned how to manipulate the dot by thought alone. One could understand the possible set of points the dot could move to as providing a map for the altiverse of choices that the monkeys could make.

4. *Compact spatial topology:* It was recently pointed out that the data from WMAP provide suggestive evidence that the universe is of finite spatial size, consisting of twelve curved pentagons joined together in a sphere about 30 billion light years across.[22] The lack of power for the larger scale fluctuations in the microwave background might be because the universe is not large enough to support such fluctuations. This situation could occur if the universe has topological identifications, making it somewhat like a cosmic house of mirrors. If this proposal survives further empirical scrutiny, then it would falsify (or at least seriously constrain) a multiverse of large spatial size. Such findings would be more congenial with the concept of an altiverse, in which out of all possible topologies, only one can be realized.

As a theological antidote to rampant replication of universes, I propose that the observable universe be embedded in an altiverse: a set of possible alternatives that logically exist but are not physically realized.

Discussion

The relationship between the telic and the ecbatic is one of the frontier avenues of study in the science/faith dialogue. While an ecbatic understanding of reality remains of crucial importance to the scientific method, it is not without its limitations. I have argued that the concept of a multiverse implies one of its key limitations, namely the implication that anything that can exist, must and does exist. Avoiding the absurdities rendered by such an implication forces a new question for theology to address: "Why is there something rather than everything?"

I have further proposed that the concept of an altiverse could be a fruitful way for theology to proceed to address this question. It asserts that the many possible states of a given physical system represent potential choices, only one of which is actualized at any particular instant. It further asserts that a transition from one state to another could occur for telic and/or ecbatic reasons. In the context of cosmology, an altiverse paradigm would assert that there is only one physical universe.

As a final comment, it is important to note that while an ecbatic understanding of reality is foundational to the scientific method, it is also incomplete. This is particularly important in the applied sciences, whose goal is to make use of our understanding of a given physical system to achieve a desired end. In this sense, a telic understanding of the world around us and our relationships within it is indispensable. Uniting this understanding with that of a cosmic teleology remains one of theology's ongoing tasks. ❋

Notes

[1]For an overview of an explanation of orthodox Christianity from a scientific perspective, see J. Polkinghorne, *The Faith of a Physicist* (Princeton, NJ: Princeton University Press, 1994).

[2]Another possibility is that of pantheism, the notion that the world is either identical with God or is in some way a self-expression of his nature. A distinct but related concept is that of panentheism, the idea that the universe is God's body, but God's awareness or personality is greater than the sum of all the parts of the universe. The former idea does not provide a particularly satisfactory response to the origin-of-God question; the latter idea is consistent with the notion of a self-created God. For further information see I. G. Barbour, *Religion and Science* (San Francisco, CA: Harper San Francisco, 1997).

[3]It is possible to imagine that life could take on a radically different character from that which we have observed (e.g., noncarbon based, different configuration of DNA basepair substructure, etc.) While this possibility is logically admissible, it is highly speculative, and there is no positive evidence in favor of it. Throughout this essay by "life," I shall mean "life as we know it"; I will not address the question as to whether a very different kind of life from that which we know could exist in a universe whose properties are quite different from our own.

[4]For an extensive description, see J. D. Barrow and F. Tipler, *The Anthropic Cosmological Principle* (New York: Oxford University Press, 1988).

[5]J. Polkinghorne, *Reason and Reality* (Harrisburg, PA: Trinity Press International, 1991).

[6]P. C. W. Davies, *The Cosmic Blueprint* (New York: Penguin, 1995).

[7]For a popular introduction, see B. W. Greene, *The Elegant Universe: Superstrings, Hidden Dimensions and the Quest for the Ultimate Theory* (Vintage, 2000).

[8]For a description of possible philosophical perspectives on the origin of the universe see P. H. Collins and G. F. R. Ellis, *Before the Beginning* (New York: Marion Boyers Publishers, 1993).

[9]For a description of the philosophical rationale behind the multiverse, see J. Leslie, *Universes* (New York: Routledge, 1996).

[10]For a more complete introduction to this idea, see L. Smolin, *The Life of the Cosmos* (New York: Oxford University Press, 1997).

[11]Ibid.

[12]R. C. Tolman, *Relativity, Thermodynamics and Cosmology*, (New York: Oxford U. Press, Clarendon Press, 1934).

[13]A. G. Reiss, et al., "Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant," *Astronomy Journal* 116 (1998): 1009; and S. Perlmutter, et al., "Measurements of Omega and Lambda from 42 High-Redshift Supernovae," *Astrophysical Journal* 517 (1999): 565.

[14]For a review, see P. Steinhardt and N. Turok, "Cosmic Evolution in a Cyclic Universe," *Physical Review* D65 (2002): 126003.

[15]For a recent pedagogical exposition, see G. S. Watson, e-print archive astro-ph/0005003; see also A. H. Guth and A. P. Lightman, *The Inflationary Universe* (Reading, MA: Perseus Press, 1998).

[16]Tolman, *Relativity, Thermodynamics and Cosmology.*

[17]See again G. S. Watson, , e-print archive astro-ph/0005003.

[18]C. L. Bennett, et al., "First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Preliminary Maps and Basic Results," *Astrophysics Journal Supplement* 148 (2003): 1; and D. N. Spergel, et al., "First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters," *Astrophysics Journal Supplement* 148 (2003): 175.

[19]H. V. Peiris, et. al., "First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Implications for Inflation," *Astrophysics Journal Supplement* 148 (2003): 213.

[20]Leslie, *Universes*.

[21]M. D. Serruya, N. G. Hatsopoulos, L. Paninski, M. R. Fellows, and J. P. Donoghue, "Instant Neural Control of a Movement Signal," *Nature* 416 (2002): 141.

[22]J. P. Luminet, J. Weeks, A. Riazuelo, R. Lehoucq, and J. P. Uzan, "Dodecahedral Space Topology as an Explanation for Weak Wide-angle Temperature Correlations in the Cosmic Microwave Background," *Nature* 425 (2003): 593.