Article

The Puzzle of Existence

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Grappling with the problem of existence is one of the central tasks of theology, one that is both challenged and illuminated by scientific inquiry. The traditional form of the problem has been that of understanding why anything exists at all. While science and theology are harmoniously complementary in addressing certain aspects of this problem, a key point of tension between them has been in evaluating the role of Mind relative to matter. This is theology's oldest challenge.

I contend that theology's newest challenge is that of understanding the particularity of existence: why it is that some things exist instead of everything. This new form of the problem of existence is motivated by findings from modern cosmology, which have been interpreted as suggesting that our universe is part of a multiverse in which all things exist. The key problem—for both science and theology—is in understanding how to distinguish what exists from what is possible.

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The puzzle of existence is a question having multiple layers of meaning, and it can be asked at a variety of levels. Most people concerned with it begin with the self. Why do I exist? Where did I come from? What does my existence mean relative to my community? What will my existence mean, if anything, in the overall context of reality? At a broader level, many people extend the question beyond themselves. Why does my community exist? Why does my environment exist, and where did it come from? Is the form of existence of my community and/or environment optimal or can it be improved somehow? At the broadest level, these kinds of questions can be asked of all of reality. Why does anything exist at all? Why does this world exist? What is the origin of all that we observe and experience?

Providing a response to the puzzle of existence is theology's oldest challenge.[1] That there is something rather than nothing cannot be taken for granted if one wishes to obtain a fully coherent understanding of reality, one that incorporates both its objective and subjective features. In theological terms, such an understanding begins with the assertion that Mind is fundamentally the root of existence, the ground of being. While this claim is thematic in all religions, it perhaps reaches its pinnacle in the Gospel of John, which begins by stating that "In the beginning was the Word, and the Word was with God, and the Word was God."[2] Θεὸς ἦν ὁ Λόγος—*Theos en o Logos*—encapsulates two coupled insights. One is that it is *Logos*—Word, Logic, Reason, Account, Meaning, Principle, Thought—that is the ultimate source of all things. The other is that this *Logos* is God, the great Other, the Mind that sources all matter.

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More succinctly, it is Intelligence that is the source of our intelligible existence.

Something instead of Nothing

Can we proceed the other way around? Can one reasonably say that a comprehensible universe has its origins in a Comprehender? To ask the question is to make certain assumptions about existence. First, the universe needs to have enough stable order so that intelligent agents can carry out investigations to discern its intelligibility. Second, the universe must not be too complicated for such agents to at least partially understand. Third, there needs to be some openness as to the possibility that a Mind might exist, along with criteria for deciding what makes such an inference reasonable.

The first two assumptions are foundational to the scientific process. From the earliest classifications that hunter-gatherer societies made about the flora and fauna of their environment to the most sophisticated theories and observations made by cosmologists of the cosmic microwave background, the whole endeavor of science presupposes the possibility of a stable order in which reason and observation can provide us with reliable knowledge. It simply would not be possible to do science otherwise.[3] One could imagine, for example, a universe (or planet for that matter) in which the environment underwent significant changes of such frequency that knowledge gathered at one time becomes nearly useless later on. For intelligent agents to survive in such an environment, it is only necessary that their physiology be able to adapt to such changing conditions and that the knowledge they have be sufficient for survival. Indeed, such conditions have been (and can be) replicated on earth in a cultural sense—unstable societies are generally not places where science flourishes.

The second assumption is of no less importance. It is quite possible for a stable universe to exist that is simply beyond the comprehension of any of its beings to understand. Consider the following example—with about 10^{58} particles per star, 10^{11} stars per galaxy and 10^{11} observed galaxies, it follows that our observable universe consists of approximately 10^{80} particles. One of the (indirect) discoveries of the past century is that all of these particles come in only a handful of types (electrons, up quarks, down quarks, neutrinos, photons, along with several other unstable particles), and that two particles of the same type are completely indistinguishable from one another. This is foundational to our understanding of particle physics.[4] Yet it is logically possible that each of these 10^{80} particles could have had distinct properties and features, in which case any comprehensive scientific formalism for describing them would be effectively impossible. Indeed, we are already aware of systems—the structure of the nucleus, weather systems, protein folding—whose enormous complexity pushes us to the limits of our ability to understand them scientifically. It is certainly conceivable that a full scientific description of them may forever elude us—though, of course, we will not know unless we try. What can be said with confidence is that the intelligibility of our universe has been of sufficient transparency to yield in large part to our scientific attempts to understand it.

The third assumption—openness to the possibility of Mind and a criterion for understanding it—has been and remains a point of considerable controversy. The comprehensibility of the universe produces a sense of awe and wonder in believer and unbeliever alike. Our comprehensible universe is perhaps best received as a gift, one to which our most profound response can only be that of deep gratitude to the One who made it possible.[5] Proceeding from wonder to gratitude is a response that comes naturally to those willing to place their faith in the Word, the *Logos* behind it all. The grand endeavor of science can be understood as a process of unwrapping this marvelous present we call the universe.

Yet this same response is deeply troubling to many. To assert the existence of Mind and furthermore to place one's faith in that Mind strikes them as a form of magical thinking, one in which rational thought has yielded to wishes and fairy tales. In contributing to our understanding of the puzzle of existence, science has proceeded by discarding magic in favor of mechanism, employing reason and observation to discern the details of this mechanism. Believers will be quick to point out that this process is not in contradiction with their perspective, and that theology is a not-dissimilar process involving reflection and revelation, which are then employed to discern the Meaning behind the mechanism.[6] Such Meaning receives its most coherent level of understanding in God, the *Logos* that empowers existence with *Telos* or Purpose. In this sense, science and theology make a joint contribution to the "why something instead of nothing" problem.

Nevertheless, most scientists do not regard the assumption of Mind as a productive scientific strategy.[7] They generally contend that there are apparently no sound criteria for making use of it, nor of its accompanying notions of meaning and purpose. It would be far better to put aside this concept entirely and proceed on the basis of what is called naturalism, an ecbatic[8] approach to understanding reality. Scientifically, this involves the assumption that explanations of observable effects are fruitful and constructive only when they hypothesize natural causes (in other words, specific mechanisms, not indeterminate miracles or magic). Going by the name of "methodological naturalism," this approach is technically agnostic and should be distinguished from the assertion that "nature is all there is and all basic truths are truths of nature," a view known as philosophical naturalism.[9] While this latter perspective is not logically implied by the former, it has been argued that the empirical success flowing from the vast body of scientific knowledge, combined with the lack of any sound criteria for discerning supernatural events or processes, makes it the only reasonable stance to adopt.[10]

This sets naturalism at odds with theism, which for many is an uncomfortable and unnecessary situation, but one that is all too common to ignore. Theists would like to understand existence rooted in Mind or *Logos*. This offers the advantage of understanding subjective experience in the same coherent framework as objective reality, speaking as much to the heart as to the mind.[11] Yet the emergence of matter from Mind is a problem that theology has not satisfactorily addressed. Naturalists prefer to understand existence in fully observable and measurable terms, with life and minds emerging from matter through fully undirected reductionist processes.[12] Proponents of this approach regard it as the most philosophically economical and empirically successful strategy to employ. Yet it ignores not only the problem of consciousness and its persistent resistance to yield to reductionism, but also does not really address the issue of what it is that puts "fire into the equations of physics and makes a universe for them to describe."[13]

Something instead of Everything

It is clear that the "something instead of nothing" problem, while old, is one that still provides interesting challenges for theology to deal with. Recently, a new theological challenge connected with the puzzle of existence has appeared on the scene, one driven by several different sources of scientific inquiry in the past few decades.

One can state the problem by means of a straightforward mathematical analogy. Any finite collection of objects can be counted as 1, simply by taking the number of objects in the set and dividing out by that number. Rather than counting all the objects in the set, we simply count the set as one object. Of course this approach will not work if there are no objects in the set—in that case, we employ the number 0, as a way of saying that there is nothing. In this simplified context, the puzzle of existence is the puzzle of why the set is not empty. Why is there 1 instead of 0?

With only slightly more sophistication we can go further with our mathematical analogy. What if we cannot count the objects in the collection because there are too many of them? No matter how large the count, there are always more to be counted. In mathematical terms, we say that the set is infinite in size, and we give it the symbol ∞. So, extending our simple analogy further, we can just as well ask the question, why is there 1 instead of ∞? Why is there something rather than everything?

This last question is one that has seldom been asked. If addressing the "something instead of nothing" question is theology's oldest challenge, the "something instead of everything" question is theology's newest challenge.[14] In principle, this question could have been asked a long time ago, since, in some sense, it is the converse of the old "something instead of nothing" question. It is clear that we inhabit a world in which something physically exists instead of nothing. It only takes a little more reflection to realize that some things do not physically exist, though they could have. This is typically trivial—that there are only ten flowers in a certain garden instead of fifteen, or that my height is 6 ft instead of an inch shorter or taller—but can entail both the fanciful (there are no unicorns) and the profound (I fortunately avoided cancer because of the timely removal of a tumor).

From this viewpoint, the "something instead of everything" question is really a puzzle of particularity. Why do certain things and events exist and not others? More generally, if something can exist—by whatever logically self-consistent criteria—why does it not exist? Most generally, why does everything not exist? Why is there not ∞ instead of 1?

This last form of the question might seem absurd, since it would appear to be obvious that everything does not exist. However, a growing body of evidence from cosmology and particle physics has suggested that perhaps this question is not so absurd. Intellectual honesty compels us to examine such evidence, from both scientific and theological perspectives, if we want to come to grips with the puzzle of existence.

Our Atypical Universe

We now have enough knowledge about our universe, at both macroscopic and microscopic scales, to ask whether it is a typical specimen out of all the possible kinds of universes one might imagine. What has emerged from the scientific body of knowledge is that the answer appears to be negative: our universe is atypical in a number of respects that are connected in unexpected and perhaps profound ways with our own existence. There are four main lines of thought pertinent to this assertion that I shall now briefly outline. Two of them—biophilic selection and cosmic fine-tuning—are "bottom-up," in that they proceed from assessment of a body of data. The other two—cosmic inflation and string theory—are "top-down," in that they originate from general scientific hypotheses concerning the structure of physical reality.

Biophilic Selection

Biophilic selection refers to the idea that the structure of our universe is constrained by the fact that it must be able to support life as we know it.[15] This seems to be a superfluous statement, since obviously there could be no scientists investigating a universe that is hostile to life. It was Brandon Carter who realized that this issue merited deeper investigation, and he wondered whether the existence of intelligent life on our planet could tell us something about the properties of the universe as a whole.[16] At the risk of oversimplification, the chain of reasoning goes like this:

1. Compare our universe—with its known constants of nature—to members of a set of possible universes that would result if these quantities had numerical values different from those we observe. One can extend this exercise to include types of particles, laws of physics, and initial conditions that are likewise modified relative to their known types and mathematical structure.

2. Ask the question: "Are the life-permitting features of our universe typical or special?" In other words, would life as we know it be common amongst other universes in the set?

The answer appears to be that life is not common.[17] Our universe appears to be very special in that it is finely tuned for the existence of many things that make it hospitable for life. This is neither obvious nor logically necessary. A simple example should suffice to make the point. Suppose we imagine a collection of universes that are alike in every respect except that the mass of the neutron differs in each one. In some universes, the neutron is heavier than the observed value of 1.674692712(13) x 10^{-27} kg that it has in our universe,[18] whereas in others it is lighter. Superficially, it might seem that such universes would trivially differ from one another, but, in fact, the difference is quite striking. In those universes where the neutron is just 0.2% lighter (or less), protons preferentially decay into neutrons (and positrons and neutrinos). It would be energetically favorable for protons everywhere to decay, leading to the absence of hydrogen and all other known atoms, and therefore to the absence of life. In universes where the neutron is just 0.2% heavier (or more), all neutrons would decay, making any atoms other than hydrogen impossible to form.

We inhabit a universe in which the neutron is just heavy enough to ensure that, as the universe cooled following the Big Bang, just enough neutrons (one for every seven protons) became bound with protons to form a rich variety of stable nuclei for atoms to form and life to exist. The excess protons end up mainly as hydrogen that goes into making long-lived stable stars, water, and a host of biomolecules, all of which are necessary for life. There are many such examples of this type that follow from modifying the known laws and constants of physics. While mathematical solutions to the equations of physics are robust to such small modifications, life as we know it is not.

Cosmic Fine-Tuning

Cosmic fine-tuning refers to the set of observations which indicate that the large-scale properties of our universe are in an apparent state of very delicate balance.[19] Put another way, the standard model of cosmology will agree with observations only when its parameters are very precisely adjusted, meaning that small changes in these parameters result in significant disagreement with observation. There are several examples of this. One is the flatness problem, which refers to the observation that the current density of our universe is very close to its critical value at which space is perfectly flat (that is, in which parallel lines remain equidistant and never meet), as opposed to being positively curved like a sphere (where such lines ultimately converge) or negatively curved like a saddle (where such lines ultimately diverge). This is easily appreciated by inspection of a simple equation from general relativity[20]

$$\left(1-\frac{\rho_c}{\rho}\right)\rho a^2=\frac{3kc^2}{8\pi G}$$

that indicates how the density of matter and energy ρ modify the curvature of space. Curvature is described by the parameter k, which takes on the values of –1, 0, or 1 for a negatively curved (saddle-like), flat, or positively curved (sphere-like) space, respectively, at a given scale factor a (which is a measure of the "size" of the universe, or rather the distance between any two spatial points at a given time). The point is that the right-hand side of this equation is constant (where c is the speed of light and G is Newton's gravitational constant), but the left-hand side contains quantities that change with time. Clearly, if $k = 0$, then $\rho=\rho_c$, meaning that the density must always have been constant at a value known as the critical density (the density needed to ensure $k = 0$), whose value is $\rho_c=10^{-26}kg/m^3$. However, we observe our universe to be expanding: the scale factor a is increasing with time less rapidly than its density is decreasing, and so ρa^2 is decreasing with time. This means that $1-\rho_c/\rho$ must increase with time to compensate. Extrapolating current observations back to the Big Bang, we find that ρa^2 has decreased by a factor of 10^{60} and so $1-\rho_c/\rho$ must have increased by the same factor. But current observations also indicate that today $|1-\rho_c/\rho|<0.01$, which means that just after the Big Bang $|1-\rho_c/\rho|<10^{-62}$. This is the flatness problem: in order to get the current model to agree with observation, we must adjust the initial density of the universe to be nearly equal to its critical density, to 62-decimal-place precision.[21]

There are several other fine-tuning situations in cosmology, most notably the horizon problem[22] and the cosmological constant problem.[23] The horizon problem refers to the fact that the temperature of the cosmic microwave background is uniform everywhere to 1 part in 30,000, but there has been insufficient time for the different regions of the universe to come into thermal contact to make this possible. A rough estimate indicates that there were about 10^{88} communication zones (distinct causal regions) shortly after the Big Bang, which means there should be 10^{88} distinct temperate regions (somewhat analogous to the different climate zones on Earth), each of which has its own characteristic temperature. The puzzle is that these 10^{88} different "cosmological climate zones" all have almost exactly the same temperature. Is there some reason for this?

The cosmological constant problem refers to the observation that our universe is accelerating in its expansion. There are several ways of modeling such expansion, but the simplest is to use a constant vacuum energy density (unlike the mass-energy density ρ, which does change with time). The problem is that the vacuum energy required to generate the observed acceleration is almost but not exactly zero, and all known attempts to compute it from general theoretical principles get the required value wrong by a factor of 10^{120}—regarded by many as the most embarrassing disagreement between theory and observation in all of science![24]

The "bottom-up" perspectives of biophilic selection and cosmic fine-tuning give us good reason to regard our universe as atypical. It is obvious that we can only live in a universe whose laws, structures, and initial conditions permit life to exist—otherwise we would not be around to discuss it! What is not so obvious is that these laws, structures, and initial conditions are quite a special subset out of the collection of possibilities.

What might this mean? This is where the "top-down" approaches come in: they provide theoretical mechanisms whereby such atypicality might be realized.

Cosmic Inflation

The first of these, cosmic inflation, was developed in response to the flatness and horizon problems.[25] While there is nothing logically inconsistent about delicately balancing the initial conditions of our universe to achieve agreement in its observed flatness and uniformity of temperature, such an approach is regarded as an unsatisfactory contrivance. Inflation is an approach that replaces this contrivance with a mechanism. The basic idea is that very shortly—only about 10^{-35} seconds—after the Big Bang, a state of matter called a false vacuum existed. This kind of matter interacts with gravity in such a way as to generate an exponentially rapid expansion of the scale factor *a*. The universe can double in size every 10^{-34} seconds via this process, so if it only happens for 10^{-32} seconds, the universe increases in size by a factor of 2^{100} or 10^{30}. A single communication zone, of near-uniform temperature, can expand by this factor, stretching out to near-perfect flatness whatever wrinkles in curvature it might have originally had. In this picture, our observable universe is a small part of this communication zone, expanding to a grapefruit-sized region after the end of this inflationary era, and then expanding more slowly over the next 13.7 billion years to become the cosmos we see today. This is a possible mechanism by which (at least some of) the features of our cosmos become fine-tuned to their apparent particularity.

The false vacuum required for inflation to work is a very peculiar state of matter. Since there is nothing for it to depend on, its energy density must be constant everywhere at all times. Suppose someone were able to place some false vacuum inside a cylinder fitted with a piston. As the piston is pulled out, there is more empty space (more vacuum), which means that more energy has been created. This energy had to come from somewhere, namely from whatever it was that was pulling the piston. This means that the piston will experience a force (equal to the extra vacuum energy inside divided by the distance the piston moved) tending to pull it back in. In other words, the false vacuum exhibits tension as well as energy. Furthermore, to conserve energy this tension must be equal in magnitude to the energy contained in any given region. It is this last property that makes the false vacuum so unusual. When the gravitational effects of this kind of energy are taken into account, it causes space to expand exponentially rapidly. A false vacuum is equivalent to a cosmological constant, so during inflation the cosmological constant is presumed large enough to cause the rapid expansion, after which spacetime undergoes a transition to our true (or perhaps I should say, less false) vacuum with its observed small cosmological constant. While there are many mechanisms for generating the cosmological constant in both the false and true vacuums, it is presently unknown which one, if any, is correct. In this picture the birth of our universe is the nucleation of a region (or bubble) of true vacuum out of false, and our observable universe is a tiny region inside this bubble.

Of course there is no guarantee that the true vacuum that forms is the one that has the properties of our vacuum. Many different kinds of bubbles can form, within which each will have its own low-energy laws of physics. So perhaps, it is conjectured, inflation happens perpetually, with an endless variety of bubbles percolating out of some primordial false vacuum. This scenario, known as eternal inflation, endlessly generates a plethora of universes.[26] In this context, eternal inflation asserts that instead of just something, there, in fact, is everything!

String Theory

Another theoretical mechanism pertinent to cosmic atypicality is string theory. This theory posits that the fundamental particles of nature are line-like instead of point-like, and so are called strings. These strings can either be open like shoelaces or closed like rubber bands. The idea is that all observed elementary particles and forces are different excitations of one string-like object, a particularly attractive unifying principle. After a period of nearly fifteen years of dormancy, string theory exploded onto the scene in the mid-1980s, when a number of calculations showed that this approach made a very special set of predictions about the basic symmetries of nature.[27] This raised expectations that further study of string theory would yield a unique theory of everything, one that predicted all constants of nature and properties of elementary particles from a single grand equation.

However, as string theory was scrutinized by large numbers of theorists, more generalizations were found instead of more mathematical restrictions, making the unique theory of everything that much more elusive. Further calculations carried out a few years ago indicated that there could be as many as 10^{500} kinds of ground states to the theory, each with its own particular properties and features.[28] Our universe is presumably described by one of these kinds. What then selects it out of this enormous cornucopia of possibilities?

This question has caused many theorists to undergo a nearly complete reversal in their perspective on the subject. Perhaps all of these different kinds of ground states—in other words, different kinds of universes—actually exist, with ours being one amongst this vast set, now referred to as the "landscape."[29] The special features of our universe, then, are what they are because every possible variant of universe that can exist is somewhere realized.

The Multiverse Paradigm

These four perspectives on the special character of our universe have motivated many scientists to consider the possibility that our universe is a very tiny part of a much larger cosmos called a *multiverse*. Biophilic selection and cosmic fine-tuning are coming to be regarded as indirect evidence that we live in such a multiverse.[30] Cosmic inflation and string theory—at least in principle—provide mechanisms for generating different kinds of universes with differing laws, structures, and initial conditions. In the multiverse paradigm, these different universes are not hypothetical entities, but instead physically exist.[31]

Such an idea may seem outlandish, but it is motivated by some observational support of cosmic inflation. Inflation makes three rather generic predictions.[32] (1) The mass-energy density ρ of the universe is close to the critical density ρ_c, and thus the geometry of the universe is flat. (2) On average, there should be equal numbers of hot and cold spots in the cosmic microwave background as compared to the average cosmic microwave background temperature. (3) Fluctuations in the primordial density in the early universe have nearly the same amplitude on all physical scales. Cosmologists are currently scrutinizing the data being collected from the Wilkinson Microwave Anisotropy Probe (WMAP) satellite to test these ideas and to plan further similar projects in the future. While there have been a few surprises, such as the large amount of dark matter (a nonluminous gravitating substance whose composition does not comprise elements from the periodic table) and dark energy (an unknown form of energy—perhaps a cosmological constant—that is causing the universe to speed up in its expansion instead of to slow down, as was originally expected), the inflationary picture has so far passed these three tests at a basic level.[33] Recalling the false vacuum picture I discussed earlier, observational support for inflation can be regarded as indirectly indicative of a multiverse: our universe is a bubble of true vacuum inside a much larger false vacuum that endlessly generates other universe-type bubbles elsewhere within it.

So why is there something rather than everything? Increasing numbers of scientists are wondering if the question is ill posed. Leaning on the circumstantial evidence noted above for a multiverse, they would argue that perhaps everything does exist! In other words, the special features of our observable universe are an inevitable consequence of the generation of a staggeringly large number (perhaps the string theory estimate of 10^{500}?) of *kinds* of universes, each with their own distinct properties. Since the universe-generating mechanism realizes all possible variants of each kind arbitrarily, often with all possible logically allowed initial conditions, ours must be one of those in the generated set.

Can this really be a satisfactory answer to the "something instead of everything" puzzle? Is it credible to believe that everything actually exists, with our universe being in a tiny corner of reality that is shielded from it all? I have argued elsewhere that the multiverse approach is a conceptual Pandora's box: once you get started on the idea, it is not clear how or where to stop.[34] Scientifically it can run out of control, and it can be theologically lethal.

The key problem is in the demarcation of the possible.[35] It is clear that what exists is a larger set than what is observed, because we are still discovering new things. The question is whether all that exists is equivalent to all that is possible.

The situation is illustrated in Figure 1 (p. 146). The smallest circle represents our observable universe: the collection of all that is known to exist. At any given time, this is finite, insofar as the amount of matter and energy in our observable universe is finite. There is good reason to believe that our universe extends beyond what can be seen with telescopes, and it is clear that we have not exhausted within our universe all that can be detected (though it can be argued that we have bounded it in terms of energy), and so what exists is much larger than what we can detect. But what line should be drawn between the possible and the existent?

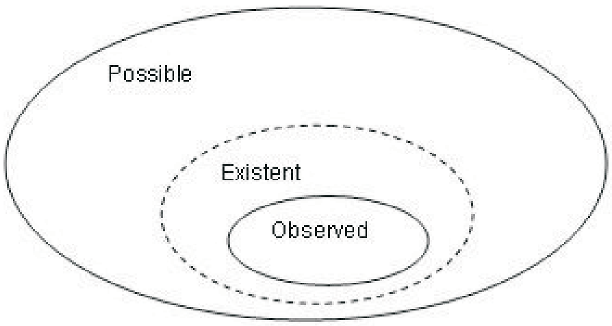

Figure 1. This diagram illustrates our observed universe within the existent universe and hints at the possible universe.

Scientifically, this is a serious challenge for multiverse theories. A given multiverse theory posits some kind of universe-generating mechanism, and then argues the case for the special features of our universe by contending that the mechanism *does* generate whatever it *can* generate. In this sense, a multiverse theory argues that the dashed line in the diagram above extends all the way to the limits of what is possible: whatever can exist, does exist. However, there is more than one way to generate universes,[36] and therefore different multiverse theories will make different claims about what is possible. This leads to a number of conundrums. What is possible in one theory might be contained within what is possible in another theory. Should we then opt for the theory in which possibility is minimized or for the theory in which possibility is maximized? Philosophical parsimony (i.e., the simplest explanation is best) would suggest the former, but the multiverse paradigm would suggest the latter. It is also conceivable that what is possible in one multiverse scenario contradicts what is possible in another, due, for example, to mutually exclusive premises. Again, by what criterion should we adopt one over the other?

It is important to recognize that these questions cannot be decided by observation and experiment, in that the multiverse paradigm—by definition—asserts that all that exists extends well beyond the capacity of observation. The special features of our universe can be explained only if our universe is one member of a very large set of existing companions whose properties are statistically spread across the spectrum of possibilities. It is also far from clear that these questions can be settled by mathematical self-consistency arguments, though there is much effort being expended in this direction.[37]

Theology's New Challenge

The relationship between the possible and the existent is theology's new question. Is it credible to believe that God created everything? Does God create (by whatever means) whatever can be created, or does the Creator make particular choices? Are there theological criteria for drawing a line, even tentatively, between the possible and the existent? If so, what are they? If not, can theology have anything useful to say about the multiverse? To probe the implications of the multiverse is to take up the challenge Zophar gave to Job, about probing the limits of the Almighty.[38]

It is a difficult challenge, one set in stark relief by the concept of the multiverse. The Bible describes God as being the source of all power,[39] having wisdom without limit,[40] and whose love is too vast to be grasped.[41] From these attributes come our concepts of an omnipotent, omniscient, and omnibenevolent God. In general—indeed, by definition—God's characteristics must be without bound. At the same time, we read that the creation is subordinate to God and is limited. The classic picture has been that of a finite creation whose origin, existence, and fulfillment depend on the limitless power of God.[42]

It is difficult to regard the multiverse as being anything other than a limitless creation. Adopting this viewpoint, the classic picture must be discarded, and a theological tension arises between the power of the Creator and the creation. Of course, tensions between different aspects of God's character are not new—the theodicy problem is the recognition of the tension between an omnipotent God and omnibenevolent God. However, in the multiverse context, new theological tensions can emerge between aspects of God's character that were previously thought to be in harmony, because in a situation where all possible outcomes are realized it is difficult to avoid a complete degeneration into absurdity. For example, the intelligibility of God reflected through a putatively elegant mathematical description of the multiverse is undermined by the imbecilic generation of all conceivable outcomes. The more pointless the universe seems the less comprehensible it becomes, to invert a well-known phrase of Weinberg.[43]

Perhaps, then, the multiverse is best eliminated from theological consideration. It is certainly tempting to regard the atypical features of our universe that are described in the framework of the anthropic principle as indicative of the selection of a Supermind, much in the same way that unusual structures such as Egyptian hieroglyphs or Ireland's Newgrange Megalithic Tomb are regarded as originating from purposeful minds instead of undirected natural processes. Yet this perspective is not without its own challenges. The first lies in how the multiverse is eliminated—how is the possible separated from the existent? There is also the question of how Mind instantiates matter, and what the link is between them.

The Duplication Dilemma

If the central challenge the multiverse presents to science and theology is that of understanding the boundary between the possible and the existent, it is not the only one. There are a number of subordinate interrelated problems that science and theology must both contend with in the context of a multiverse paradigm. There is not the space to discuss them all here, so I shall deal with one: the Duplication Dilemma.

Ellis and Bundrit first noted the Duplication Dilemma (as I call it) in the context of investigating the simplest kind of multiverse, though they did not use that term.[44] Consider a universe that is infinite in spatial extent and in which there is an unbounded amount of energy, everywhere obeying the laws of physics in our observable patch. Suppose now that these laws are valid everywhere. A simple kind of multiverse can be obtained here by simply allowing matter and energy to realize all possible configurations that are permitted by the known laws of physics. No quantum mechanics is required to do this—one is simply exploring the possibility that there is enough time, space, and matter to realize all possible known configurations of every allowed physical system. One can regard the universe-generating mechanism as being a random generation of initial conditions, spread out over spatial regions that are typically larger than the 10^{26} meters in size of our observable horizon.

One such physical system is the human body—your own, for example. Since human DNA has a finite number of configurations, your body will have a duplicate in this infinite universe. It is possible to estimate how far away this body-double is—about $10^{10^{29}}$ meters away from here.[45] Of course, this is but the nearest of many duplicates—infinitely many, since we have allowed the universe to have unbounded matter and energy. Most of these will be only physically identical, with presumably different personalities due to differing environments and circumstances. However, some will be nearly the same because the local environments and circumstances will also be nearly the same. In fact, our planet, our solar system, and our galaxy will also have complete duplicates. The nearest region of space that is identical to ours (one hundred light years across) can be estimated to be about $10^{10^{91}}$ meters away, and our nearest duplicate observable universe, about $10^{10^{118}}$ meters away.

Vast numbers, to be sure—but nonetheless finite. Such duplicates will occur infinitely many times since there are no bounds to the physical resources at the disposal of even this simple multiverse. Moreover, there will be proportionately even more duplicates that are imperfect copies. Taking this to its extreme, it means that any given physical system, individual, or society will experience everything it can experience. Furthermore, at any given instant in which you made an apparent choice, there is an equivalent situation somewhere out there in which your duplicate made a different choice. If you have ever wondered what life might be like if you had not met your spouse, taken that job, or passed that test, you can be confident that somewhere else in the multiverse your duplicates have had these experiences.

This might seem like a quaint and benign inference, more science-fiction than fact. Quaint it may be, but benign it is not. The reason for this is that all possible social, psychological, and physical outcomes occur from any given set of near-indistinguishable initial conditions. Specifically, all possible experimental outcomes occur for a given physical system somewhere in the multiverse. Two sets of near-identical observers could measure wildly different outcomes from the same set of conditions, with one set of observers inferring quite distinct forms of scientific regularity.[46] In what sense can we then say science is left with any predictive power? If we decide to restrict science only to our observable patch, then what is the point of introducing the multiverse in the first place? One is also left with the question of how one rules out unlikely outcomes on the basis of chance. Any phenomenon contradicting known science within a patch might just as well be attributed to being in a quirky location in the multiverse. Indeed, since everything that can occur does occur, one is ultimately left with a reasonless explanation for any given phenomenon.

Duplication poses interesting theological challenges as well. These have been discussed elsewhere, and have primarily concentrated on a loss of uniqueness.[47] If I am replicated many times in the multiverse, in what sense can I be understood to be a child of God, being worth more than many sparrows? To be sure, loss of uniqueness is a theological issue, one too easily dismissed by its critics. But it is not the only issue. Duplication presents a serious challenge to Christology.

If there are many duplicate worlds, then presumably there are many duplicate Christs. Pursuing the line of reasoning that follows from allowing all initial conditions, in some parts of the multiverse Jesus dies on the cross and in others he does not. What then do we make of the concepts of atonement and salvation? Do they only apply to those "lucky" parts of the multiverse where Jesus chose the path of sacrifice? Is Christ to be identified with God only in those sacrificial sectors? Does God so love only certain parts of this multiverse?

Note that these problems can be avoided (or at least ameliorated) if one imposes the theological constraint that all the duplicate Christs choose the path of sacrifice. This is fine, but it undermines the motivation behind this simple multiverse in the first place, which was to generate universes by random initial conditions. To impose such a constraint is to eliminate this randomness. But why stop there? Why not constrain such randomness so as to eliminate as many theologically uncomfortable duplicates as possible?

In fact, why not eliminate the multiverse entirely? This can be done by getting rid of infinite space, replacing it with finite spatial sections, or by revisiting the homogeneity principle in cosmology, so that the universe is not on average the same everywhere and so that not all initial conditions are realized.[48] Of course, one then needs to provide some kind of scientific/philosophical rationale that induces one (or both) of these possibilities.

Summary

I have outlined here what I believe is at stake in coming to grips with the puzzle of existence in view of modern science. The problem of *creatio ex nihilo*—why something instead of nothing—is one that continues to have an ongoing fruitful interaction in the science/theology dialogue. The key challenge is in understanding the role of Mind relative to that of matter. Though far from universally accepted, it does seem that a more coherently satisfying picture of reality is one in which the intelligibility of the universe is taken to be indicative of an Intelligence behind it. From a Christian stance, the challenge is both to understand in what way this Mind can be identified with the God of the Bible (since they clearly cannot be distinct) and to understand the relationship between this Mind and matter—how God both instantiates and interacts with the universe.

The other problem—why something instead of everything, or *creatio ex omnia*—is a new problem of considerably greater challenge, both scientifically and theologically. The central problem is that of the boundary between the possible and the existent. Asserting that there is no boundary—that everything that can exist, does exist—appears to undermine the basic foundations of scientific and theological reasoning.[48] Yet the rationale for how such a boundary should be delineated is far from clear. Even if one accepts provisionally that some boundary can be drawn, there are a considerable number of other difficulties a multiverse presents in both science and theology. The Duplication Dilemma is one example that I sketched out above. Further examples include problems with scientific elegance, empirical testability, spontaneous creation, unbounded evil, purpose, and free will.

It might be argued that these difficulties are being exaggerated. After all, there is an active body of scientific researchers examining models of the multiverse, with a number of cosmologists arguing that it provides the best explanation for the atypicality of our universe. It has further been argued that the multiverse is not incompatible with a theistic perspective, as it essentially pushes arguments from design and intelligibility up to a meta-level.[49] Perhaps we simply need to relax our demands of science and broaden our concept of God.

In my view, such arguments are too sanguine. It is not at all clear that the multiverse paradigm is scientifically beneficial. It is even less clear that this paradigm can be reconciled with any reasonable form of Christian theology. A far more critical analysis from scientific, philosophical, and theological perspectives needs to be applied in examining the multiverse paradigm. What ought we to expect from science in terms of providing a description of reality? What ought we to expect from theology in terms of providing an explanation for existence?

Is *creatio ex omnia* a meaningful concept?

Notes

[1]For a discussion in the context of modern cosmology, see William Lane Craig, "Philosophical and Scientific Pointers to Creation *ex Nihilo*," in *Contemporary Perspectives on Religious Epistemology*, ed. R. Douglas Geivett and Brendan Sweetman (New York: Oxford University Press, 1992), 191.

[2]John 1:1; Bible quotations are from the New International Version.

[3]For a discussion of this point, see J. Polkinghorne, *The Faith of a Physicist* (Princeton, NJ: Princeton University Press, 1994).

[4]For a nontechnical introduction, see L. M. Lederman and D. Teresi, *The God Particle: If the Universe Is the Answer, What Is the Question?* (Boston, MA: Houghton Mifflin Harcourt, 2006).

[5]Of course awe and gratitude are not just the prerogative of theists—the universe is so spectacular that even nontheists can appreciate its grandeur. However, gratitude has an intrinsically relational character—we are not only thankful *for*, we also offer thanks *to*. To be grateful for our understanding of the universe raises the question as to what entity our gratitude should be directed toward.

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

[7]See, for example, F. Wilczek, "A Model of Anthropic Reasoning: The Dark to Ordinary Matter Ratio," *Universe or Multiverse?* ed. B. Carr (New York: Cambridge University Press, 2007), 151.

[8]For a more complete description of the meaning of this term, see R. Mann, "Inconstant Multiverse," *PSCF* 57, no. 4 (2005): 302.

[9]*The Encyclopedia of Philosophy*, 1996 Supplement, s.v. "Naturalism."

[10]B. Forrest, "Methodological Naturalism and Philosophical Naturalism: Clarifying the Connection," *Philo* 3, no. 2 (Fall–Winter 2000): 7–29.

[11]For a full discussion of this kind of broad integration, see N. Murphy and G. F. R. Ellis, *On the Moral Nature of the Universe* (Minneapolis, MN: Augsburg Fortress Publishers, 1996).

[12]F. Crick, *The Astonishing Hypothesis* (New York: Scribner, 1994).

[13]K. Ferguson, *The Fire in the Equations: Science, Religion, and the Search for God* (Grand Rapids, MI: Eerdmans, 1995).

[14]I have stated this in "Inconstant Multiverse."

[15]For the first comprehensive discussion of this, see J. D. Barrow and F. Tipler, *The Anthropic Cosmological Principle* (New York: Oxford University Press, 1988).

[16]B. Carter, "Large Number Coincidences and the Anthropic Principle in Cosmology," *IAU Symposium 63: Confrontation of Cosmological Theories with Observational Data* (Dordrecht: Reidel, 1974), 291–8.

[17]For an early discussion of this, see J. Leslie, *Universes* (New York: Routledge, 1989).

[18]Brackets around numbers denote errors in the final digits of an expression. For example, 1.54378(12) means 1.54378 +/– 0.00012.

[19]B. J. Carr and M. J. Rees, "The Anthropic Cosmological Principle and the Structure of the Physical World," *Nature* 278 (1979): 605–12.

[20]For a derivation of this equation, see S. Weinberg, *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity* (New York: John Wiley and Sons, 1972).

[21]W. J. Kaufmann III, *Universe*, 4th ed. (New York: W. H. Freeman and Co., 1993).

[22]For a discussion, see J. Barrow, *Theories of Everything* (New York: Ballantine Books, 1992).

[23]S. Weinberg, "The Cosmological Constant Problems" in *Marina del Rey 2000, Sources and Detection of Dark Matter and Dark Energy in the Universe,* ed. D. B. Cline (New York: Springer-Verlag, 2001), 18–26.

[24]L. Susskind, *The Cosmic Landscape: String Theory and the Illusion of Intelligent Design* (New York: Little, Brown and Company, 2005).

[25]A. H. Guth, "The Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems," *Physical Review* D23 (1981): 347; A. Linde, "A New Inflationary Universe Scenario: A Possible Solution of the Horizon, Flatness, Homogeneity, Isotropy and Primordial Monopole Problems," *Physics Letters* B108 (1982): 389; see also A. H. Guth, *The Inflationary Universe* (New York: Basic Books, 1998).

[26]For a nontechnical description of this and other aspects of inflation, see A. Vilenkin, *Many Worlds in One* (New York: Hill and Wang, 2006).

[27]M. B. Green and J. Schwarz, "Anomaly Cancellation in Supersymmetric D=10 Gauge Theory and Superstring Theory," *Physics Letters* B149 (1984): 117; for some readable introductions to string theory pro and con, see respectively Brian Green, *The Fabric of the Cosmos: Space, Time, and the Texture of Reality* (New York: Vintage, 2005) and Lee Smolin, *The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next* (Boston, MA: Houghton Mifflin Harcourt, 2006).

[28]For a readable introduction, see R. Bousso and J. Polchinski, "The String Theory Landscape," *Scientific American* 291 (2004): 60.
[29]See Susskind, *The Cosmic Landscape* for further details.
[30]Ibid.
[31]For a collection of articles that address this subject from a variety of perspectives, see Carr, *Universe or Multiverse?*
[32]See Vilenkin, *Many Worlds in One* for further discussion.
[33]The most recent cosmological results and their interpretation appear in E. Komatsu et al., "Five-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation," *Astrophysical Journal Supplement* 180 (2009): 330.
[34]See Wilczek in Carr, *Universe or Multiverse?*
[35]Here the term "possible" refers to everything that can self-consistently exist based on the premises of a given theory. For further discussion, see P. Davies, *Cosmic Jackpot* (Boston, MA: Houghton Mifflin Harcourt, 2007).
[36]For examples, see Leslie, *Universes*.
[37]See D. Page, "Cosmological Measures without Volume Weighting," *Journal of Cosmology and Astroparticle Physics* 0810:025 (2008) for a recent discussion and references therein.
[38]Job 11:7.
[39]Deuteronomy 3:23–25.
[40]Psalm 147:5.
[41]Romans 8:39.
[42]Job 38: 4–11.
[43]S. Weinberg, *The First Three Minutes,* 2d ed. (New York: Basic Books, 1993).
[44]G. F. R. Ellis and G. B. Bundrit, "Life in the Infinite Universe," *Journal of the Astronomical Society* 20 (1979): 37.
[45]For a more detailed discussion of these estimates, see Kaufmann, *Universe*.
[46]Strictly speaking, quantum mechanics is needed to infer these kinds of distinctions, but in practical terms this does not matter. Most experiments are well beyond quantum limits in determining their sources of error, and so conditions that appear identical to experimentalists can lead to vastly different results, at least in principle. The point is that even the most unlikely outcomes can appear in situations that appear identical to our own at any point in time, as long as it is logically possible, given the initial conditions.
[47]For example, see D. Page, "Does God So Love the Multiverse?" to appear in *Science and Religion in Dialogue*, ed. M. Y. Stewart (Oxford: Blackwell Publishing Inc., in press).
[48]Job 11:7.
[49]It is generally thought that science deals with what is "probable" based on our knowledge to date, rather than with what is possible, and for most scientific disciplines this pragmatic approach is satisfactory. However, what is probable depends on what is possible, and in dealing with the subject of cosmology, considerations of the boundary of the possible necessarily come into consideration.
[50]For further discussion, see Page, "Does God So Love the Multiverse?" and R. Collins, "The Multiverse Hypothesis: A Theistic Perspective," in Carr, *Universe or Multiverse?* 459.