http://magisgodwiki.org/index.php?title=Cosmology

Cosmology

Jump to: navigation, search

The Magis God Wiki: Cosmology

Is there Evidence of the Existence of God from Contemporary Physics?

This will be an overview of a more complex treatment which may be found in my recent book New Proofs for the Existence of God: Contributions of Contemporary Physics and Philosophy (hereafter "NPEG"). I have given a series of lectures on these matters in an on-line series called Physics and Metaphysics in Dialogue which can be accessed at our (hereafter "PID") website – see lectures #1-6. It will be rather quick paced, and if some of you want a more thorough treatment you may want to refer to the book. I will divide the topic into three parts:

1. Can Science Give Evidence of Creation and Supernatural Design?

2. What is the Evidence for a Beginning and what are the Implications for Creation?

3. What is the evidence of Supernatural Intelligence from Anthropic Fine-tuning?

Can Science Give Evidence of a Creation and Supernatural Design?

We should begin by clarifying what science can really tell us about a beginning of the universe and supernatural causation. First, unlike philosophy and metaphysics, science cannot deductively prove a creation or God. This is because natural science deals with the physical universe and with the regularities which we call "laws of nature" that are obeyed by the phenomena within that universe. But God is not an object or phenomenon or regularity within the physical universe; so science cannot say anything about God. Moreover, science is an empirical and inductive discipline. As such, science cannot be certain that it has considered all possible data that would be relevant to a complete explanation of particular physical phenomena or the universe itself. It is always open to new data and discoveries which could alter its explanation of particular phenomena and the universe. This can be seen quite clearly in revisions made to the Big Bang model.

So what can science tell us? It can identify, aggregate, and synthesize evidence indicating that the finitude of past time in the universe as we currently know it to be and conceive it could be. Science can also identify the exceedingly high improbability of the random occurrence of conditions necessary to sustain life in the universe as we currently know it to be and conceive it could be.

Even though scientific conclusions are subject to modification in the light of new data, we should not let this possibility cause us to unnecessarily discount the validity of long-standing, persistent, rigorously established theories. If we did this, we might discount the majority of our scientific theories. Thus, it is reasonable and responsible to attribute qualified truth value to such theories until such time as new data requires them to be modified.

What is The Evidence for a Beginning and what are the Implications for Creation?

The arguments that suggest the finitude of past time (i.e. that time had a beginning) are basically of two types: (a) arguments about the possible geometries of spacetime and (b) arguments based on the Second Law of Thermodynamics (entropy). Though the arguments we shall give may conceivably have loopholes, in the sense that cosmological models or scenarios may be found in the future to which these arguments don't apply, their persistence and applicability to a large number of existing cosmological models gives them respectable probative force. Until such time as they are shown to be invalid or inapplicable to empirically verifiable characteristics of our universe, they should be considered as justifying the conclusion that it is at least probable that the universe had a beginning.

A Beginning in Physics Implies A Creation of the Universe

Before examining this evidence, it is essential to discuss the implications of a beginning (in physics) for a creation of our universe. A beginning in physics implies a Creator. Because a beginning in physics marks a point at which the universe came into existence. In physics, time is something real, and it has real effects on other physical phenomena. Thus, the point at which the universe comes into existence is also the point at which physical time comes into existence.

How does this imply a Creator? First, in physics, nothing physical could exist prior to the beginning point (indeed there is no "prior to the beginning point" because there is no physical time).

Secondly, if the physical universe (and its physical time) did not exist prior to the beginning, then it was literally nothing. It is important to note that "nothing" means "nothing." It does not mean a "vacuum" or "a low energy state of a quantum field," "empty space," or other real things. Vacuums, empty space, and low energy states in quantum fields are dimensional and orientable – they have specific characteristics and parameters, but nothing is not dimensional or orientable, and it does not have any specific characteristics or parameters because it is nothing. For example, you can have more or less of a vacuum or empty space, but you cannot have more or less of nothing because nothing is nothing.

Thirdly, nothing can do only nothing, because it is nothing. To imply the contrary is to make nothing into something. The classical expression was, "from nothing, only nothing comes."

Fourthly, if nothing can't do anything, then it certainly cannot create anything. Thus, when the universe was nothing, it could not have created itself (made itself into something) when it was nothing, because when it was nothing, it could only do nothing.

Finally, if the universe could not have made itself something when it was nothing, then something else would have had to have made the universe something when it was nothing, and that "something else" would have to be completely transcendent (completely independent of the universe and beyond it). This transcendent (and independent) creative force beyond our universe (and its space-time asymmetry) is generally termed "a Creator." Therefore, a beginning in physics implies a transcendent powerful creative force (a "Creator").

Was the Big Bang the Beginning?

In view of the fact that a beginning in physics implies a Creator, many physicists with a naturalistic orientation would like to avoid the necessity of such a beginning. For this reason, they have proposed that the big bang was not the beginning of the universe. Before we can assess this hypothesis, we will want to get a few facts about the contemporary big bang theory.

The Big Bang Theory was proposed originally by a Belgium priest by the name of Fr. George Lemaitre who used it to resolve a problem (the radial velocities of extra galactic nebulae) connected with Einstein's General Theory of Relativity. Though Einstein did not at first affirm the idea of an expanding universe, he later believed it because of its overwhelming verification. Indeed, it is one of the most rigorously established theories in physics today.

Essentially, the contemporary Big Bang Theory holds that the big bang occurred approximately 13.7 billion years ago (plus or minus 200 million years). It may be analogized to a balloon blowing up where the elastic on the balloon is like the space-time field (in general relativity, space-time can actually stretch, expand as a whole, warp, vibrate, and change its coordinate structure according to the density of mass-energy in it).

Now, going back to our analogy, suppose there are paint spots all over the balloon; notice that as the balloon expands (i.e. as space-time stretches and expands as a whole), all the paint dots (which may be likened to galaxies) move away from each other. Our universe has been doing something like this for 13.7 billion years.

Our observable universe seems to have a finite amount of mass-energy. It has approximately 4.6% visible matter (matter-energy that can emit light, electromagnetic fields, etc.), 23% dark matter (interacts with gravity, but does not seem to have luminescent or electromagnetic activity), and 72.4% dark energy (which seems to be like a field attached to a space-time field causing space-time to accelerate in its expansion). The visible matter in our universe seems to be approximately 1055 kilograms which is approximately 1080 baryons (protons and neutrons – particles with significant rest mass).

Since the time of Fr. Lemaitre, the Big Bang Theory has been confirmed by multiple, distinct data sets which come together around a similar set of numbers and values: Edwin Hubble's' Redshifts (which shows that all galaxies are moving away from each other), Arno Penzias' and Robert Wilson's discovery of the 2.7 degree Kelvin uniformly distributed radiation which is the remnant of the big bang, evidence from the cosmic background explorer satellite (COBE), and further evidence from the Wilkinson Microwave Anisotropy Probe (WMAP). This is why most physicists consider the big bang to be a rigorously established physical theory.

Was the big bang the beginning of the universe? Many physicists think that it was because the big bang was the moment at which space-time came into existence and because there is no physical evidence for a period prior to the big bang. However, some physicists believe that the big bang was not the beginning of our universe which opens the possibility for a pre-big-bang period of indefinite length (perhaps avoiding a beginning and all of its implications for a creation). This hypothetical pre-big-bang period is made possible through quantum cosmology (which allows the universe to operate in a space-time smaller than the minimums required by general relativity). Currently, string theory is one hypothetical candidate for quantum cosmology in which some physicists (including Stephen Hawking) have placed considerable hope. (Those of you interested in additional detail on quantum cosmology and string theory will want to read the Postscript to Part One of NPG). String Theory allows for the possibility of higher-dimensional space, which in turn, allows for two possible pre-big bang periods:

1. A multiverse (a mega universe which coughs out multiple bubble universes, one of which is our universe) and

2. An oscillating universe in higher dimensional space (e.g. two three dimensional membranes interacting and colliding through a four dimensional bulk space-time).

It is not important to know all the details of a multiverse or an oscillating universe in higher dimensional space, because there is only one relevant question. Do these speculative scenarios themselves require a beginning or can they go indefinitely back into the past? It so happens that a considerable amount of work has been done in the area of space-time geometry proofs which conclude that all inflationary model universes, multiverses (which must be inflationary in order to exist), and oscillating universes in higher dimensional space must have a beginning. These extraordinary proofs suggest the probability that our universe (or any multiverse in which it might be situated) must have a beginning, which implies a Creator. So what are these proofs?

Evidence of a Beginning from Space-Time Geometry Proofs

There are three pieces of evidence arising out of space-time geometry proofs which indicate a beginning of our universe or any speculative multiverse in which our universe might be situated.

It also indicates a beginning of oscillating universes – even oscillating universes in higher dimensional space. These proofs are so widely applicable that they establish a beginning of virtually every hypothetical pre-big bang condition which can be connected to our universe. They, therefore, indicate the probability of an absolute beginning of physical reality which implies the probability of a Creator outside of our universe (or any multiverse in which it might be situated).

Since 1994 two proofs and (and a series of models) have been developed that show that not only our universe, but any multiverse and inflationary bouncing universe must have a beginning: 1) The 1994 Borde-Vilenkin Proof, 2) The modeling of inflationary universes by Alan Guth and others, and 3) The 2003 Borde-Vilenkin-Guth Theorem (the BVG Theorem).

The 1994 Borde-Vilenkin Proof

Arvin Borde (Kavli Institute of Theoretical Physics at the University of California Santa Barbara) and Alexander Vilenkin (Director of the Institute of Cosmology at Tufts University) formulated a proof in 1994 that every inflationary universe meeting five assumptions would have to have a singularity (a beginning of the universe/multiverse in a finite proper time)[1]. Our universe meets all the conditions in this proof. In 1997 they discovered a possible exception to one of their assumptions (concerning weak energy conditions) which was very, very unlikely within our universe. Physicists, including Alan Guth (the Victor Weisskopf Professor of Physics at the Massachusetts Institute of Technology, and father of inflationary theory) did not consider this exception to be relevant: "… the technical assumption questioned in the 1997 Borde-Vilenkin paper does not seem important enough to me to change the conclusion [that the 1994 proof of a beginning of inflationary model universes is required]."[2] Therefore, the 1994 proof still has general validity today. (Refer to NPEG Chapter One, Section IV.D)

Alan Guth's 1999 analysis of expanding pre-big-bang models

Guth concluded his study as follows: "In my own opinion, it looks like eternally inflating models necessarily have a beginning… As hard as physicists have worked to try to construct an alternative, so far all the models that we construct have a beginning; they are eternal into the future, but not into the past."[3]

(Refer to NPEG Chapter One, Section IV.D)

The 2003 Borde-Vilenkin-Guth Theorem (the BVG Theorem):

Borde, Vilenkin, and Guth joined together to formulate an elegant and vastly applicable demonstration of a beginning of expanding universes (in a famous article in Physical Review Letters). Alexander Vilenkin explains it as follows:

"Suppose, for example, that [a] space traveler has just zoomed by the earth at the speed of 100,000 kilometers per second and is now headed toward a distant galaxy, about a billion light years away. [because of the expansion of the universe as a whole], that galaxy is moving away from us at a speed of 20,000 kilometers per second, so when the space traveler catches up with it, the observers there will see him moving at 80,000 kilometers per second. [As the universe continues to expand, the relative velocity of the space traveler will get smaller and smaller into the future]. If the velocity of the space traveler relative to the spectators gets smaller and smaller into the future, then it follows that his velocity should get larger and larger as we follow his history into the past. In the limit, his velocity should get arbitrarily close to the speed of light [the maximum velocity attainable by mass energy in the universe]."[4]

The point where relative velocities become arbitrarily close to the speed of light constitutes a boundary to past time in any expanding universe or multiverse. Though the conclusion of Borde, Vilenkin, and Guth is somewhat technical for non physicists, its importance makes their precise words worth mentioning:

Our argument shows that null and time like geodesics are, in general, past-incomplete [requiring a boundary to past time] in inflationary models, whether or not energy conditions hold, provided only that the averaged expansion condition Hav > 0 hold along these past-directed geodesics. This is a stronger conclusion than the one arrived at in previous work in that we have shown under reasonable assumptions that almost all causal geodesics, when extended to the past of an arbitrary point, reach the boundary of the inflating region of space-time in a finite proper time.[5]

This proof is vastly applicable to just about any model universe or multiverse that could be connected with our universe. Alexander Vilenkin put it this way in 2006:

We made no assumptions about the material content of the universe. We did not even assume that gravity is described by Einstein's equations. So, if Einstein's gravity requires some modification, our conclusion will still hold. The only assumption that we made was that the expansion rate of the universe never gets below some nonzero value, no matter how small. This assumption should certainly be satisfied in the inflating false vacuum. The conclusion is that past-eternal inflation without a beginning is impossible. [6]

Physicists do not use the word "impossible" very often. So, Vilenkin's claim here is quite strong. The reason he is able to make it is that there is only one condition that must be fulfilled – an expansion rate of the universe greater than zero (no matter how small).

It is important to note that Borde, Vilenkin, and Guth applied their theorem to the string multiverse as well as to higher dimensional oscillating universes. I present their own words here (which might be quite difficult for non-physicists) because it gives a sense of their own appreciation of the vast applicability of their theorem:

Our argument can be straightforwardly extended to cosmology in higher dimensions [arising out of string theory/M Theory]. For example, [1] in [some models of a string multiverse], brane worlds are created in collisions of bubbles nucleating in an inflating higher-dimensional bulk space-time. Our analysis implies that the inflating bulk cannot be past-complete [i.e. must have a boundary to past time]. ¶ [2] We finally comment on the cyclic Universe model [in the higher dimensional space of string theory] in which a bulk of four spatial dimensions is sandwiched between two three-dimensional branes…In some versions of the cyclic model the brane space-times' are everywhere expanding, so our theorem immediately implies the existence of a past boundary at which boundary conditions must be imposed. In other versions, there are brief periods of contraction, but the net result of each cycle is an expansion.…Thus, as long as Hav > 0 for a null geodesic when averaged over one cycle, then Hav > 0 for any number of cycles, and our theorem would imply that the geodesic is incomplete [i.e. must have a boundary to past time].[7]

The boundary to past time (required in the BVG theorem) could indicate an absolute beginning of the universe or a pre-pre-big bang era with a completely different physics. If it is the latter, then the pre-big-bang period would also have to have had a boundary to its past time (because it would have a rate of expansion greater than zero). Eventually, one will reach an absolute beginning when there are no more pre-pre-pre-big-bang eras.

This is an extraordinary conclusion, because it shows that a beginning is required in virtually every conceivable pre-big-bang scenario – including the string multiverse and oscillating universes in higher dimensional space. By implication, then, even if there were multiple pre-big-bang eras, it is likely that these eras would have to have an expansion rate greater than zero, which means that they too would have to have a beginning, which would make an absolute beginning virtually unavoidable. This absolute beginning would be the point at which the universe came into existence. Prior to that point the universe (and its physical time) would have been nothing, which as we saw above, implies a Creator.

Exceptions to this theorem are very difficult to formulate and are quite tenuous because they require either a universe with an average Hubble expansion less than or equal to zero (which is difficult to connect to our inflationary universe) or a deconstruction of time which is physically unrealistic. (For an extended discussion of these exceptions, you may consult Chapter One, Section III.D-E of NPEG). For this reason all attempts to get around the BVG Theorem to date have been unsuccessful. Even if physicists in the future are able to formulate a hypothetical model which could get around the BVG Theorem, it would not mean that this hypothetical model is true for our universe. It is likely to be only a testimony to human ingenuity. Therefore, it is probable that our universe (or any multiverse in which it might be situated) had an absolute beginning. This implies a creation of the universe by a Power transcending our universe.

There is another impressive set of data which corroborates the above three space-time geometry proofs, namely, the Second Law of Thermodynamics (i.e. entropy). The constraints of time will not permit me to address this topic, however, those interested in explication of it may consult Chapter One (Section III A-C) of NPEG). In conclusion, the evidence from physics (from both space-time geometry proofs and the second law of thermodynamics) indicates the probability of a beginning of our universe. In as much as a beginning indicates a point at which our universe came into existence, and prior to that point, the universe was nothing, then it is probable that the universe (and any hypothetical multiverse in which it might be situated) was created by a transcendent power outside of physical space and time.

Implications of Supernatural Intelligence in the Fine-tuning of Universal Constants

There are several conditions of our universe necessary for the emergence of any complex life form. Many of these conditions are so exceedingly improbable that it is not reasonable to expect that they could have occurred by pure chance For this reason many physicists attribute their occurrence to supernatural design. Some other physicists prefer to believe instead in trillions upon trillions of “other universes” (which are unobserved and likely unobservable). Before discussing which explanation is more probative, we need to explore some specific instances of this highly improbable fine-tuning. We may break the discussion into two parts:

1. The exceedingly high improbability of our low entropy universe, and

2. The exceedingly high improbability of the anthropic values of our universe’s constants.

We will discuss each in turn.

The high improbability of a pure chance occurrence of our low-entropy universe

A low-entropy universe is necessary for the emergence, development, and complexification of life forms (because a high entropy universe would be too run down to allow for such development). Roger Penrose has calculated the exceedingly small probability of a pure chance occurrence of our low–entropy universe as 10^10^123 to one. How can we understand this number? It is like a ten raised to an exponent of:

1000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000.

This number is so large, that if every zero were 10 point type, our solar system would not be able to hold it! Currently, there is no natural explanation for the occurrence of this number, and if none is found, then we are left with the words of Roger Penrose himself:

“In order to produce a universe resembling the one in which we live, the Creator would have to aim for an absurdly tiny volume of the phase space of possible universes—about 1/10^10^123 of the entire volume, for the situation under consideration.”

What Penrose is saying here is that this occurrence cannot be explained by a random (pure chance) occurrence. Therefore, one will have to make recourse either to a multiverse (composed of bubble universes, each having different values of constants) or as Penrose implies, a Creator (with a super-intellect).

The high improbability of five other anthropic conditions (based on cosmological constants)

A cosmological constant is a number which controls the equations of physics, and the equations of physics, in turn, describe the laws of nature. Therefore, these numbers control the laws of nature (and whether these laws of nature will be hospitable or hostile to any life form). Some examples of constants are: the speed of light constant (c= 300,000 km per second), Planck's constant ($\hbar$ = 6.6 x 10-34 joule seconds), the gravitational attraction constant (G = 6.67 x 10-11), the strong nuclear force constant (gs = 15), the weak force constant (gw = 1.43 x 10-62), the mass of the proton (mp = 1.67 x 10-27 kg), rest mass of an electron (me = 9.11 x 10-31 kg), and charge of an electron proton (e = 1.6 x 10-19 coulombs). There are several other constants, but these pertain to the following anthropic coincidences (highly improbable conditions required for life).

(i) If the gravitational constant (G) or weak force constant (gw) varied from their values by an exceedingly small fraction (higher or lower) -- one part in 10^50 (.00000000000000000000000000000000000000000000000001) then either the universe would have suffered a catastrophic collapse or would have exploded throughout its expansion, both of which options would have prevented the emergence and development of any life form. This cannot be reasonably explained by pure chance.

(ii) If the strong nuclear force constant were higher than its value (15) by only 2%, there would be no hydrogen in the universe (and therefore no nuclear fuel or water -- this would have prohibited life). If, on the other hand, the strong nuclear force constant had been 2% lower than its value then no element heavier than hydrogen could have emerged in the universe (helium, carbon, etc). This would have been equally detrimental to the development of life. This "anthropic coincidence" also seems to lie beyond the boundaries of pure chance.

(iii) If the gravitational constant, electromagnetism, or the "proton mass relative to the electron mass" varied from their values by only a tiny fraction (higher or lower), then all stars would be either blue giants or red dwarfs. These kinds of stars would not emit the proper kind of heat and light for a long enough period to allow for the emergence, development, and complexification of life forms. Again, these "anthropic coincidences" are beyond pure chance occurrence.

(iv) If the weak force constant had been slightly smaller or larger than its value, then supernovae explosions would never have occurred. If these explosions had not occurred, there would be no carbon, iron, or earth-like planets.

(v) Fred Hoyle and William Fowler discovered the exceedingly high improbability of oxygen, carbon, helium and beryllium having the precise values to allow for both carbon abundance and carbon bonding (necessary for life). This "anthropic coincidence" was so striking that it caused Hoyle to abandon his previous atheism and declare:

“A common sense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. The numbers one calculates from the facts seem to me so overwhelming as to put this conclusion almost beyond question.”

(For all five “anthropic coincidences,” refer to NPEG Chapter One, Sect. II and Lectures #5 and 6 of PID.)

The odds against all five of the anthropic coincidences happening randomly is so exceedingly improbable that it is like telling a monkey to type out the corpus of Shakespeare perfectly by random tapping of the keys. After returning two weeks later the entire corpus of Shakespeare, Hamlet, Macbeth, Richard III, are all perfectly recounted. Most reasonable and responsible individuals would not attribute this to random occurrence (because the odds are so overwhelmingly against it), and so, they look for another explanation which is more reasonable and responsible.

For this reason, no respectable physicist (including Stephen Hawking), believes that these anthropic coincidences can be explained by pure chance. In view of the fact that no natural explanation has been found for them, most physicists have made recourse to two trans-universal explanations:

1. A multiverse (a naturalistic explanation) and

2. A super intellectual Creator (a supernatural explanation).

Is the naturalistic explanation more reasonable and responsible? Not necessarily because the other universes (and the multiverse itself) are in principle unobservable. Furthermore, it violates the principle of parsimony (Ockham’s Razor) – the explanation with the least number of assumptions, conditions, and requirements is to be preferred. As Paul Davies notes:

Another weakness of the anthropic argument is that it seems the very antithesis of Ockham’s razor, according to which the most plausible of a possible set of explanations is that which contains the simplest ideas and least number of assumptions. To invoke an infinity of other universes just to explain one is surely carrying excess baggage to cosmic extremes … It is hard to see how such a purely theoretical construct can ever be used as an explanation, in the scientific sense, of a feature of nature. Of course, one might find it easier to believe in an infinite array of universes than in an infinite Deity, but such a belief must rest on faith rather than observation.[8]

3. All known multiverse theories have significant fine-tuning requirements. Linde’s chaotic inflationary multiverse cannot randomly cough out bubble universes because they would collide and make both universes inhospitable to life; the bubble universes must be spaced out in a slow roll which requires considerable fine-tuning in the multiverses initial parameters.[9] Similarly,

Susskind’s String Theory landscape requires considerable meta-level fine-tuning to explain its “anthropic" tendencies.[10]

Conclusions

Given these problems, is the multiverse a more reasonable and responsible explanation of our universe’s anthropic coincidences? Many physicists believe that it is not, not only because of the above three problems, but also because of the likelihood of a Creator. When the evidence for a beginning (a Creator) is combined with the exceedingly high improbability of the above anthropic coincidences, a super intellect may be the most reasonable and responsible explanation because it avoids all the problems of a hypothetical multiverse. Thus, it is both reasonable and responsible to believe on the basis of physics, that there is a very powerful and intelligent being that caused our universe to exist as a whole.

Footnotes

1. ↑ See Borde and Vilenkin 1994
2. ↑ Guth 1999 pg. 1.
3. ↑ Guth 1999 pg. 1.
4. ↑ Vilenkin 2006 p. 173.
5. ↑ Borde, Guth, and Vilenkin 2003 p. 3
6. ↑ Vilenkin 2006 p.175.
7. ↑ Borde, Guth, and Vilenkin 2003 p. 4.
8. ↑ Davies 1983, pp. 173-174.
9. ↑ See Alabidi and Lyth 2006.
10. ↑ See Gordon 2010 pp. 100-102.