The Case for Cosmic Design (2008)

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Theoretical physicist Paul Davies writes that, when looking at the overall structure of the universe, "the impression of design is overwhelming" (1988, p. 203). I agree. And the famous atheist philosopher, Antony Flew, has also come to agree, citing the appearance of cosmic design as the main reason for his conversion to belief in some sort of intelligent designer.[1] During the last one hundred years, physicists have discovered at least three features of the universe that point to a transcendent, intelligent designer:

> **(i) The so-called fine-tuning of laws, constants, and initial conditions of the universe for complex life of comparable intelligence to ourselves.**
>
> **(ii) The extraordinary beauty and elegance of the laws and mathematical structure of the universe.**
>
> **(iii) The intelligibility and discoverability of the basic structure of nature.**

I will briefly look at each of these in turn, and then at why they count as significant evidence for design.

The Evidence

Fine-Tuning of Laws for Life

The fine-tuning for life refers to the fact that the laws of nature, the constants of physics, and the initial conditions of the universe are set just right for life to occur. To begin, consider the laws of nature. To say that the laws are fine-tuned means that if we did not have just the right combination of laws, complex intelligent life would probably be impossible. For example, according to current physics, there are four forces in nature--gravity, the weak force, electromagnetism, and the strong nuclear force that binds protons and neutrons together in an atom. The existence of each of at least three of these forces is necessary for complex life, and probably the fourth. If gravity did not exist, masses would not clump together to form stars or planets; if the electromagnetic force didn't exist, there would be no chemistry; if the strong force didn't exist, protons and neutrons could not bind together and hence no atoms with atomic number greater than hydrogen would exist. Other principles of physics also appear necessary for embodied observers. For example, as Princeton physicist Freeman Dyson has pointed out (1979, p. 251), if the Pauli exclusion principle did not exist--which is what keeps two electrons from occupying the same energy state in an atom--all electrons would occupy the lowest atomic energy state, and thus no complex atoms could exist. Thus, if any of these fundamental laws or principles were missing, the existence of complex, intelligent life would probably be rendered impossible.

Fine-Tuning of Constants

Next, consider the fine-tuning for life of the constants of physics. The constants of physics are fundamental numbers that when plugged into the laws of physics determine the basic structure of the universe. An example of a fundamental constant is Newton's gravitational constant G, which determines the strength of gravity via Newton's law F = Gm1m2/r2. Many of the fundamental constants must fall into a *relatively* narrow range in order for complex life to exist.

To illustrate this fine-tuning, consider gravity. Using a standard measure of force strengths--which turns out to be roughly the relative strength of the various forces between two protons in a nucleus--gravity is the weakest of the forces, and the strong nuclear force is the strongest, being a factor of 1040--or ten thousand billion, billion, billion, billion--times stronger than gravity. If we increased the strength of gravity a billion-fold, for instance, the force of gravity on a planet with the mass and size of the earth would be so great that organisms anywhere near the size of human beings, whether land-based or aquatic, would be crushed. (The strength of materials depends on the electromagnetic force via the fine-structure constant, which would not be affected by a change in gravity.) Even a much smaller planet of only 40 feet in diameter--which is not large enough to sustain organisms of our size--would have a gravitational pull of one thousand times that of earth, still too strong for organisms of our brain size, and hence level of intelligence, to exist. As astrophysicist Martin Rees notes, "In an imaginary strong gravity world, even insects would need thick legs to support them, and no animals could get much larger" (2000, p. 30). Of course, a billion-fold increase in the strength of gravity is a lot, but compared to the total range of the strengths of the forces in nature (which span a range of 1040 as we saw above), it is very small, being one part in ten thousand, billion, billion, billion. Indeed, other calculations show that stars with lifetimes of more than a billion years, as compared to our sun's lifetime of ten billion years, could not exist if gravity were increased by more than a

factor of 3000. This would have significant intelligent-life-inhibiting consequences (see Collins, 2003).

The most impressive case of fine-tuning for life is that of the cosmological constant. The cosmological constant is a term in Einstein's equation of general relativity that, when positive, acts as a repulsive force, causing space to expand and, when negative, acts as an attractive force, causing space to contract. If it were too large, space would expand so rapidly that galaxies and stars could not form, and if too small, the universe would collapse before life could evolve. In today's physics, it is taken to correspond to the energy density of empty space. The fine-tuning for life of the cosmological constant is estimated to be *at least* one part in 10^53, that is, one part in a one hundred million, billion, billion, billion, billion, billion. To get an idea of how precise this is, it would be like throwing a dart at the surface of the earth from outer space, and hitting a bull's-eye one trillionth of a trillionth of an inch in diameter, less than the size of an atom! Nobel laureate Steven Weinberg, a critic of fine-tuning, himself admits that the fine-tuning of the cosmological constant is highly impressive (2001, p. 67; also, see Collins, 2003).

Further examples of the fine-tuning for life of the fundamental constants of physics can also be given, such as that of mass difference between the neutron and the proton. If, for example, the mass of the neutron were slightly increased by about one part in seven hundred, stable hydrogen burning stars would cease to exist (Leslie, 1989, pp. 39-40; Collins, 2003).

Other Types of Fine-Tuning for Life

Two other types of fine-tuning should be mentioned. One is that of the initial conditions of the universe, which refers to the fact that the initial distribution of mass-energy--as measured by entropy--must fall within an exceedingly narrow range for (intelligent) life to occur. According to Roger Penrose, one of Britain's leading theoretical physicists, "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" (Penrose, 1989, p. 343). How tiny is this volume? According to Penrose, if we let x =10^123, the volume of phase space would be about 1/10x of the entire volume. (p. 343). (Phase space is the space that physicists use to measure the various possible configurations of mass-energy of a system.) This precision is much, much greater than the precision that would be required to hit an individual proton given the entire visible universe were a dart board! Finally, in his book *Nature's Destiny*, biochemist Michael Denton extensively discusses various higher-level features of the natural world, such as the many unique properties of carbon, oxygen, water, and the electromagnetic spectrum, that appear optimally adjusted for the existence of complex biochemical systems (1988, p. 300).

It should be pointed out that some physicists and scientists have been skeptical of some of the prominent cases of fine-tuning in the literature. As I have shown in detail elsewhere, in some cases this skepticism is warranted, but in other cases the arguments based in physics for the fine-tuning are solid (see Collins, 2003). Nonetheless, even if none of the cases of purported fine-tuning were well-established, the argument would still have significant force. As philosopher John Leslie has pointed out, "clues heaped upon clues

can constitute weighty evidence despite doubts about each element in the pile" (1988, p. 300).

Summary of Fine-Tuning for Life Argument

These cases of fine-tuning presented above have often been cited as providing significant evidence that the cosmos is designed. The reason is that, because of the exceedingly special conditions required for the existence of life, it seems very improbable or surprising that the initial conditions, laws, and constants would be adjusted just right for highly complex life under what I call the *naturalistic single-universe hypothesis*, but not surprising under theism. Thus, the fine-tuning provides significant evidence for theism over the naturalistic single-universe hypothesis. (The naturalistic single-universe hypothesis is the hypothesis that there is only one universe and it exists as a brute, inexplicable fact.)

Beauty and Elegance of Laws

The beauty and elegance of the laws of nature also point to Divine design. Nobel Prize winning physicist Steven Weinberg, for instance, devotes a whole chapter of his book *Dreams of a Final Theory* to explaining how the criteria of beauty and elegance are commonly used with great success to guide physicists in formulating laws. As Weinberg points out, "mathematical structures that confessedly are developed by mathematicians because they seek a sort of beauty are often found later to be extraordinarily valuable by the physicist" (1992, p. 153). Later, Weinberg comments that "Physicists generally find the ability of mathematicians to anticipate the mathematics needed in the theories of physics quite uncanny" (1992, p. 157). Indeed, one of the most prominent theoretical physicists of this century, Paul Dirac, has gone so far as to claim, as Einstein did, that "it is more important to have beauty in one's equations than to have them fit experiment" (1963, p. 47). The beauty, elegance, and ingenuity of mathematical equations make sense if the universe was purposefully designed like an artwork, but appear surprising and inexplicable under the nondesign hypothesis. Weinberg, who is a convinced atheist, even admits that "sometimes nature seems more beautiful than strictly necessary" (1992, p. 250).

Some have claimed that the beauty we see in nature is merely subjective, like seeing the Big Bear or Big Dipper in the random pattern of stars in the night sky. To say that the beauty of the mathematical structure of nature is merely subjective, however, completely fails to account for the amazing success of the criterion of beauty in producing predictively accurate theories, such as Einstein's general theory of relativity. We would not expect merely subjective impressions to lead to highly successful theories.[2]

Intelligibility and Discoverability

Finally, the laws of Nature themselves seem to be carefully arranged so that they are intelligible, and in addition discoverable, by beings with our level of intelligence--like solving a clever puzzle. This has been stressed by many prominent physicists. Albert Einstein, for example, famously remarked that "the eternal mystery of the world is that it is comprehensible.... The fact that it is comprehensible is a miracle" (Quoted in Calaprice,

1996, p. 197). Similarly, in his famous essay, "The Unreasonable Effectiveness of Mathematics in the Physical Sciences," Eugene Wigner, one of the principal founders of quantum mechanics, famously claimed that "The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve" (1960, p. 14). As theoretical physicist Paul Davies notes,

> a common reaction among physicists to remarkable discoveries of the sort discussed above is a mixture of delight at the subtlety and elegance of nature, and of stupefaction: 'I would never have thought of doing it that way.' If nature is so 'clever' that it can exploit mechanisms that amaze us with their ingenuity, is that not persuasive evidence for the existence of intelligent design behind the physical universe? (1984, pp. 235-36)

Further, Davies notes, "uncovering the laws of physics resembles completing a crossword in a number of ways.... In the case of the crossword, it would never occur to us to suppose that the words just happened to fall into a consistent interlocking pattern by accident...." (1984, pp. 235-36).

Work on articulating detailed examples of this intelligibility and discoverability has just begun in the last ten years. For example, Philosopher Mark Steiner's recent book, *The Applicability of Mathematics as a Philosophical Problem* (1998), is devoted to this issue, where he concludes that the world is much more "user friendly" for the discovery of its fundamental mathematical structure than seems explicable under naturalism (1998, p. 176)[3].

Summary of Argument: Method of Inference

All these features of the laws of nature, let alone the fact that our best theories seem to require that the universe have a beginning, give the impression that the universe was created by some transcendent intelligence. The form of inference here can be thought of as what philosophers call a cumulative case argument in which many factors, such as the fine-tuning, the beauty, intelligibility, and discoverability of the laws of nature, all point in the same direction, and seem difficult to explain on any other hypothesis. In this sense, the above case is very similar to the sort of arguments offered for scientific theories, such as the theory of evolution by descent with modification. As evolutionary biologist and geneticist Edward Dodson summarizes the case for evolution, understood as the thesis of common ancestry:[4]

> All [pieces of evidence] concur in *suggesting* evolution with varying degrees of cogency, but most can be explained on other bases, albeit with some damage to the law of parsimony. The strongest evidence for evolution is the concurrence of so many independent probabilities. That such different disciplines as biochemistry and comparative anatomy, genetics and biogeography should all point toward the same conclusion is very difficult to attribute to coincidence" (1984, p. 68).

The case for design as I have presented is of the same form and, I believe, as strong as

that for evolution. The cumulative case form of our argument is particularly strong, since even if skeptics can explain away one type of evidence for design, they would still have to deal with the other types of evidences listed above.

At this point, one might want to inquire further as to why each feature mentioned above counts as evidence in favor of design. What rule of inference is being used? One rule of inference is that if a body of data E is inexplicable under one hypothesis H1, but makes sense under another hypothesis H2, then it counts as evidence in favor of H1 over H2. The fine-tuning of the universe for life, and the beauty, elegance, intelligibility, and discoverability of the laws of nature each seems inexplicable under naturalism (or in the case of the fine-tuning for life, the naturalistic single-universe hypothesis).[5] Theists, however, have traditionally held that God is the greatest possible being and hence is perfectly good and has a perfect aesthetic sense. Given these attributes of God, it makes sense that God would create a universe that is fine-tuned for the existence of embodied, conscious moral agents and that has an elegant underlying mathematical structure, since both the existence of conscious moral agents and beauty are positive goods, everything else being equal. Further, given that God is the ultimate cause of both the universe and the human mind, it makes sense that the universe would be intelligible to us. These features of our universe, therefore, make sense under theism, but are inexplicable under naturalism, and hence provide evidence for theism over naturalism.

This argument gains additional force when we note that these features are not only inexplicable under naturalism, but seemingly very improbable or surprising. This in turn leads to an additional way of articulating why these features count as evidence for theism over naturalism in terms of what is known as the *likelihood principle*, a principle that not only taps into much current work on the nature of scientific inference but, I believe, articulates why many find this cumulative case argument so powerful. Because of this, I will spend some time explaining this form of the argument, though I would stress that we could rest our case on the above rule of inference based on the inexplicability of these features of the universe under naturalism. The likelihood principle simply provides another somewhat independent means of securing and strengthening our claim that these features provide significant evidence for theism.

Elaboration of Likelihood Principle

According to the likelihood principle, an event or state of affairs E counts as evidence in favor of an hypothesis H1 over H2 if E is more probable under H1 than H2, with the degree of support proportional to the ratio of probabilities under the two respective hypotheses.[6] The likelihood principle shows why an ink splotch that looks like the face of Abraham Lincoln would support the idea that the splotch was designed, whereas a splotch of random looking ink marks would not. Although the exact details of both kinds of ink marks are highly improbable under the chance hypothesis, only in the former case are the ink marks *not* highly improbable under the design hypothesis.

One common objection to our likelihood account of why these features count as evidence, which is based on a misunderstanding, is that we are merely arguing from the purported improbability of the existence of one of the above features under naturalism (or the

naturalistic single-universe hypothesis). Then the objection goes, very improbable events occur all the time. For example, the exact pattern of any ink splotch is very improbable--never to be repeated in the history of human beings--and yet most of them do not signal design. The premises of the likelihood version of the design argument, however, are not merely that the existence of certain features of the universe are improbable (or surprising) under naturalism or the naturalistic single-universe hypothesis, but that they are also *not* very improbable (or surprising) under theism. As we saw in above example of the Lincoln-like ink splotch, both of these conditions are necessary for one to claim that these features support theism over naturalism using the likelihood principle.[7]

It is critical to point out that the sort of probability used here is not statistical probability, since this would require that the universe be generated by some physical process that churns out life-permitting universes at some relative frequency, contrary to the assumption of typical forms of naturalism that claim the universe is simply a brute fact. Rather, the probability used here is what philosophers call *epistemic* probability, which can be thought of as a measure of rational degrees of expectation. For example, when scientists say that the theory of evolution is *probably* true, they are clearly not talking about statistical probability: they are *not* referring to some repeatable trial in which the theory turns out true with some relative frequency. Rather, they are saying something to the effect that given the total body of available evidence, a rational person should expect that the theory of evolution is true.

Put in terms of epistemic probability, the likelihood principle can be reworded in terms of *degrees of expectation* instead of probability, in which case it becomes what I call the *expectation principle*. According to the expectation principle, if an event or state of affairs E is more to be expected under one hypothesis H1 than another H2, it counts as evidence in favor of H1 over H2--that is, in favor of the hypothesis under which it has the highest expectation. The strength of the evidence is proportional to the relative degree to which it is more to be expected under H1 than H2. Rewording the likelihood principle in this way is particularly helpful for those trained in the sciences, who are not familiar with epistemic probability and therefore tend to confuse it with other kinds of probability, even when they are aware of the distinction. Given this rewording, the central premises of our argument become that the various features of the universe mentioned above are very surprising (unexpected) under naturalism (or the naturalistic single-universe hypothesis), but not under theism, and thus they provide evidence for theism over naturalism.

One might question this use of epistemic probability on the grounds that it is merely subjective. One response to this objection is that epistemic probability is used, and needed, for many widely accepted inferences in everyday life and science. For example, as the above quotation by Edward Dodson illustrates, the support for the thesis of common ancestry (evolution) is based the claim that a variety of features of the world--such as the structure of the tree of life--would not be improbable if evolution is true, but would be very improbable under the other viable nonevolutionary hypotheses, such as special creation. This improbability is not statistical improbability, nor can it be justified by an appeal to statistical improbability, since we have no statistics regarding the relative frequency of life on a planet having these features under either the evolutionary hypothesis or some nonevolutionary hypothesis. Neither do we have any model from

which to derive those statistics. Thus, if it were a statistical probability, it would be completely unjustified. Rather, it should be understood as a form of epistemic probability--e.g., as claiming that various features of the world would be very *unexpected* under the various contender nonevolutionary hypotheses, but not under the evolutionary hypothesis. Further, since we have no statistical models on which to base our judgments of epistemic probability (especially for the nonevolutionary hypotheses), I contend that these judgments of epistemic probability are not rigorously justified. Rather, after (hopefully) doing the best job of looking at the evidence, scientists and laypersons make judgments of what kind of world we should expect under each hypothesis, and then they simply trust these judgments. This sort of trust in our judgments of epistemic probability--that is, what we should rationally expect under various hypotheses--is a pervasive and indispensable feature of our intellectual life.

This same kind of reasoning is what is going on in the likelihood rendition of our argument: we look at the various features of the universe mentioned above, and judge that they are very surprising under naturalism, but not under theism. Then, as in the case of evolution, after a careful analysis of the evidence, we trust our judgments of epistemic probability in deciding the strength of the evidence. What if someone does not share these judgments of epistemic probability? One can either appeal to how widely shared these judgments are by those who are relevantly informed, or one can attempt to provide a deeper justification of them. In this regard, it should be noted that the judgment that features of the universe such as beauty and discoverability are surprising under naturalism is widely shared by intelligent, informed individuals, as some of the scientists and philosophers cited above illustrate. I believe, however, that a more rigorous, deeper justification can be offered.[8] For example, in the case of the fine-tuning for life, I base the claim that an (intelligent) life-permitting universe is very surprising under the naturalistic single-universe hypothesis on the relative smallness of the range of the parameters of physics that allow for embodied, intelligent life, along with a revised version of the probabilistic principle of indifference. My point here, however, is that although such justification is nice to have, even if it were not offered, that should not undermine the claim that the above features provide evidence, via the likelihood principle, for theism over naturalism, just as it does not in the analogous scientific cases.

Of course, the skeptic might object that scientific theories are testable, whereas the theistic explanation is not. But why should testability be epistemically relevant? After all, testability is about being able to find evidence for or against a theory in the future. What matters for the likelihood of an hypothesis's (approximate) truth, however, is the current evidence in its favor, not whether it is possible to find evidence for or against it in the future. Thus, I contend, the design argument is on as solid ground in terms of the method of inference being deployed as many arguments we accept in science. It is dishonest, therefore, to accept one sort of inference without rigorous justification, but reject the other merely because it purportedly lacks such justification.

Because these features of the universe offer a *prima facie* case for design--based both on the inexplicability under naturalism and on the likelihood principle--the burden is now on the skeptic to show what is wrong with the argument. To get a sense of the sort of objections commonly raised to the argument for design from the above features, along

with the sort of responses that can be given, we will end by considering two major objections raised against the most discussed version of this argument, that from the fine-tuning of the cosmos for life.[9]

Objections to the Fine-Tuning for Life Argument

Grand Unified Theory Objection

One common objection is that, as far as we know, the values of the fundamental parameters will eventually be explained by some grand unified theory. Hence, it is argued, we do not need to invoke a designer to explain why these parameters have life-permitting values. As astrophysicists Bernard Carr and Martin Rees note, however, "even if all apparently anthropic coincidences could be explained [in terms of such a unified theory], it would still be remarkable that the relationships dictated by physical theory happened also to be those propitious for life" (1979, p. 612). For the theist, then, the development of a grand unified theory would not undercut the case for design, but would only serve to deepen our appreciation of the ingenuity of the creator. Instead of separately fine-tuning each individual parameter, in this view, the designer simply carefully chose those laws that would yield life-permitting values for each parameter.[10]

Many-Universes Objection

Another objection to considering fine-tuning for life as evidence for design is one that takes us almost into the realm of science fiction: the proposal that there are a very large number of universes, each with different values for the fundamental parameters of physics. If such multiple universes exist, it would be no surprise that the parameters in one of them would have just the right values for the existence of intelligent life, just as in the case where if enough lottery tickets were generated, it would be no surprise that one of them would turn out to be the winning number. Further, it is no surprise that we observe that *our* universe has these values, since they are necessary for our existence.

How did these universes come into existence? Typically, the answer is to postulate some kind of physical process, what I will call a "universe generator." Against the naturalistic version of the universe-generator hypothesis, one could argue that the universe generator itself must be "well designed" to produce even one life-sustaining universe. After all, even a mundane item such as a bread-making machine, which only produces loaves of bread instead of universes, must be well-designed as an appliance *and* have just the right ingredients (flour, yeast, gluten, and so on) in just the right amounts to produce decent loaves of bread. Indeed, as I have shown in detail elsewhere,[11] if one carefully examines the most popular and most well-developed universe-generator hypothesis, that arising out of inflationary cosmology, one finds that it contains just the right fields and laws to generate life-permitting universes. Eliminate one of the fields or laws, and no life-sustaining universes would be produced. Finally, neither the universe-generator hypothesis nor even the hypothesis that all possible universes simply exist as a brute fact can explain the other design-indicating features of our universe mentioned above, such as why *our* universe has an elegant, intelligible, and discoverable underlying mathematical

structure.

Despite these objections to the naturalistic version of the universe generator hypothesis, I am not objecting to the notion of many universes or even a universe generator. For the theist, the existence of a many universes would simply support the view that creation reflects the *infinite creativity* of the creator, who is so creative that he/she not only creates a reality with an enormous number of planets and galaxies, but also one with many universes. God could create these universes directly or by means of creating a universe generator.

Conclusion

Much work still remains to be done on the above argument from design to make it more rigorous. In the meantime, we can confidently say, many features of the fundamental structure of the universe strongly point to a transcendent intelligence behind the universe.

Continue the Debate

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Notes

[1] See, for example, the interview of Flew in *Philosophia Christi*, available at <http://www.biola.edu/antonyflew/flew-interview.pdf>

[2] For more on beauty in physics as evidence for design, see Collins, 2002b and my website, <www.fine-tuning.org>

[3] See also a brief discussion of my work on discoverability, which presents some concrete examples, in Gonzalez and Richards, 2001, pp. 214-215 and at <www.fine-tuning.org>

[4] According to the thesis of common ancestry, all life arose from an initial simple life form by the process of descent with modification. The evidence cited below is really evidence for this thesis, not the more general thesis that unguided chance plus natural selection was the mechanism by which this happened.

[5] By naturalism I mean the thesis that physical reality was not a result of some transcendent intelligence.

[6] To deal with certain potential counterexamples, one might also restrict the principle to *non-ad-hoc hypotheses*, such as hypotheses which were advocated by people before the discovery of these features of the universe. For current discussions of the likelihood principle, see Swinburne, 2002.

[7] The fine-tuning of the constants of physics for life only confirms theism over the naturalistic single-universe hypothesis, since it is not improbable under naturalistic versions of the many-universes hypothesis. (See below.)

[8] See, for instance, Collins, 2002a and <www.fine-tuning.org>

[9] Other objections are given in my articles and on my website <www.fine-tuning.org>

[10] I am, however, skeptical that such a unified theory will be developed: current attempts have been unsuccessful at reducing the number of free parameters--the standard model of particle physics has twenty four, and it looks like string theory generates its own effective free parameters that have to be set just right for a complex life-permitting universe to exist (Zwiebach, 2004, p. 9).

[11] See Collins 2002b; also, <www.fine-tuning.org>
