POST-AGNOSTIC SCIENCE: HOW PHYSICS IS REVIVING THE ARGUMENT FROM DESIGN

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1. Anthropic Coincidences

In 1973, astronomer and cosmologist Brandon Carter (Carter 1974) delivered a lecture in which he announced an exciting new discovery: the fundamental constants of the physical world must have been very delicately fine-tuned in order to make life possible. Since that time, literally dozens of such remarkable coincidences have been discovered, the so-called ``anthropic coincidences". (``Anthropic" is a Greek word meaning ``tending to bring about the existence of human beings.")

For example, the ratios of the four fundamental forces, gravity, electromagnetism, and the strong and weak nuclear forces, had to be balanced with great precision in order to make the universe hospitable to life.

Concerning the weak nuclear force:
If significantly stronger: fusion at the big bang would have proceeded directly to iron, giving us a star-free universe.

If significantly weaker: an all-helium universe would result.

The weak nuclear force must be extremely weak compared to the other forces, yet just strong enough to make supernovas possible.

Concerning the strong nuclear force:
If 2 percent stronger: this would prevent the formation of protons.
If 1 percent stronger: all carbon would have been turned into oxygen.
If 1 percent weaker: no carbon would have been formed from beryllium.

Concerning electromagnetism:
if slightly stronger: all red stars, no supernovae
if slightly weaker: all fast-burning blue dwarves

A very remarkable case of fine-tuning has to do with the smoothness of the universe as it emerged from the Big Bang. The universe had to be extremely smooth, or else it would have been packed with nothing but black holes. At the same time, there had to be just the right amount of lumpiness to the early universe, to make the formation of stars and galaxies possible. Mathematician Roger Penrose (Penrose 1981) has estimated that the margin of error permitted here was less than 1 in 10 to the 10 to the 123rd power (that is, 1 followed by 10 to the 123rd power zeros, more zeros than there are particles in the universe!)

One solution to the this smoothness problem is offered by the theory of an inflationary Big Bang, a Big Bang in which there is a very brief period of very rapid expansion at the very beginning. However, such expansion requires an even more impressive feat of fine-tuning. For inflation to take place, the value of the cosmological constant had to take a very small and very precise value.

The cosmological constant is the result of the almost perfect cancellation of a very large number of comparatively very large physical constants. For example, a change in the strength of the gravitational or nuclear force as little as one part in 10 to the 100th could entirely ruin the cancellation, making space expand or contract furiously.

There are many more coincidences of this kind than we can even mention in the short time available, coincidences involving the proton/electron mass ratio, the fine structure constant, the necessity for a universe with exactly 3 spatial dimensions, the necessity of Pauli's exclusion principle and the quantization of the energy levels of the atom, the electrical neutrality of matter, and so forth. Hugh Ross, in *The Creator and the Cosmos* (Ross 1995), lists over thirty such coincidences, most of which are clearly independent of the others.

If any of these features of the universe had lied outside a narrow interval of values, then the existence of any sort of complex chemistry would have been impossible. Complex, self-replicating life seems to depend on the co-existence of a combination of lighter and heavier elements, including such elements as hydrogen, oxygen and carbon. Furthermore, life seems to depend on the formation of stars and planetary systems, since no life could exist in the frigidity of starless deep space or within the superheated interiors of stars. These conditions are interconnected, since only if stars can form and later become supernovas can any of the heavier elements be formed. These processes of star formation and destruction turn out to be very sensitive to the slightest variations in the fundamental constants of the universe. Consequently, the universe is in some sense "fine-tuned" for the possibility of complex chemistry and thus of life.

How surprising are these coincidences? This depends on what philosophers call your prior probabilities. If I knew nothing about the ratio of electromagnetic force to gravitational force, and if I knew nothing about the importance of this ratio to life, I would certainly assign a very low prior probability to that ratio's lying within an interval that is no wider than one part in 10 to the 40th power. Thus, discovering both that there is such an interval defining the conditions of life, and that the actual value does lie within

that interval, is to discover something that would be very surprising to any reasonable investigator. These surprising discovery seems to call for some explanation.

Paul Davies :

[There] is for me powerful evidence that there is something going on behind it all... It seems as though somebody has fine-tuned nature's numbers to make the Universe... The impression of design is overwhelming. [Davies 1988, p. 203]
Arno Penzias (Nobel prize winning physicist):
Astronomy leads us to a unique event, a universe which was created out of nothing, one with the very delicate balance needed to provide exactly the conditions required to permit life, and one which has an underlying (one might say "supernatural") plan. [in Margenau and Varghese 1992, p. 83.]
In addition, physicists are concluding that ours is the simplest possible universe, consistent with the existence of life. It appears that our universe has been deliberately designed so as to permit life and to maximize the simplicity of its laws.

2. Do the Anthropic Coincidences Require an Explanation?

I would like to turn to six objections that have been made to the claim that it is desirable, or even possible, to explain the anthropic coincidences.

2.1 The Problem of Old Evidence

We already know that life exists, and, consequently, we know that whatever is physically required for life to exist must be actual. Any hypothesis that purports to ``explain" the coincidences is explaining something we already know to be true. It is not thereby making a risky prediction that may or may not be borne out by subsequent observation. Hypotheses can be confirmed or made more probable only when they make such risky predictions, as when Halley predicted the return of Halley's comet, or Einstein predicted the bending of light by the sun's gravity.

This objection can be illustrated by using Bayes's theorem, a basic theorem of probability theory. Bayesians stipulate that the posterior probability of a hypothesis, after observing result **E**, is equal to **P(H/E)**. According to Bayes's theorem, **P(H/E)** is equal to the product of **P(H)**, the prior probability of **H**, and **P(E/H)**, the degree to which **H** made **E** probable, divided by **P(E)**, the prior probability of **E**. The probability of **H** is increased if two conditions are met: (i) **P(H)** is not zero, (ii) **P(E/H)** is greater than **P(E)**. If **E** is not a prediction, then we already know **E** to be true. In this case, **P(E)** is **1**, and **P(E/H)** cannot be greater than **P(E)**. This means that no hypothesis can be confirmed by **E**. This implication of Bayes's theorem is called ``the problem of old evidence".

Most philosophers of science believe that this apparent implication of Bayesian theory should not be accepted. There are many cases in the history of science in which a theory

was accepted on the basis of its ability to explain, in a very simple way, a wide range of previously-known data. For instance, Copernicus's theory was accepted entirely on the basis of its providing a simpler, more economical explanation of astronomical data that had been known for hundreds, or even thousands of years. According to the strict Bayesian account, this data should have provided no support whatsoever to Copernicus's theory -- an incredible result.

The standard solution to the problem goes something like this. Instead of using the actual probability of the data, **E**, in using Bayes's theorem, we instead use a hypothetical probability value, one representing how likely we would have found **E** to be, had we never actually observed it. Thus, the astronomical data we have observed for many thousands of years could receive a very low hypothetical probability, representing how unlikely these observations would have been to one unfamiliar with them.

Applying this solution to the case of the anthropic coincidences, we would have to assign some hypothetical probability to the anthropic coincidences. Given the narrowness of the required intervals, how surprising is it that life actually came into being? The answer would seem to be, very unlikely (unless there are a large number of actual universes within which life could arise by chance).

John Leslie illustrates this point by means of the Firing Squad analogy (Leslie 1989, pp. 13-14). Imagine that you are facing a firing squad of sharpshooters, firing at close range. Somehow, you survive the volley. Is the volley something that requires an explanation? It is old evidence -- you already know with probability 1 that you are still alive. Nonetheless, it is, from a suitably impersonal perspective, a very surprising thing that you did survive, under the circumstances. Similarly, we already know, with probability 1, that life exists, but this is a very surprising fact, given the anthropic coincidences that were required.

2.2 Laws of Nature Cannot Be Explained

Some have objected that the anthropic coincidences cannot be explained, since they involve the fundamental laws of nature. The laws of nature are used in explaining other things -- they themselves cannot be explained. They are rock-bottom, matters of physical necessity, immutable and uncaused. This objection is sometimes based on actual scientific practice -- scientists seek to discover the laws of nature and to use these laws in constructing explanations of phenomena. They do not try to explain the laws of nature themselves.

There are several points to make in response to this. First, it is no longer true that scientists never seek to explain the laws of nature. Much of recent cosmology and unified force theory has attempted to do that. Second, even if scientists never did attempt to explain the fundamental laws, it would still be an open question whether they should do so. Finally, whether something can or should be explained is itself an empirical matter, to be decided on a case by case basis, and not on the basis of dogmatic, a priori pronouncements. The anthropic coincidences are themselves excellent evidence that the

laws of nature can and should be explained. If the laws really were absolute rock bottom, inexplicable brute facts, then we would be faced with a set of inexplicable coincidences. If the only price we have to pay in order to explain these coincidences is to revise our beliefs about the rock-bottom status of physical laws, this is a small price to pay.

There is an episode near the end of Carl Sagan's novel, *Contact*, that illustrates this point. A mathematician discovers, hidden in the apparently random sequence of numbers in the binary expansion of pi, an encrypted, three-dimensional hologram of the cosmos. The further the binary expansion is carried out, the sharper is the resolution of the hologram. Further, the hologram gives absolutely accurate information about the relative positions of galaxies and galaxy clusters, leading to new discoveries about the cosmos. In light of this discovery, the only possible conclusion to draw is that the number pi is an artifact, created by some unfathomable intellect, who encoded it with this astronomical information. In advance of this remarkable discovery, no one would have thought of the value of pi as something that could be explained in terms of anything else. It seems like a mathematical brute fact, rock bottom if anything is. However, this conviction is subject to change in the light of new information. Similarly, the discovery of the anthropic coincidences should lead us to revise our prior conviction that the fundamental laws and constants of the universe could not be explained.

2.3 Something Had to Happen -- The Problem of Specification

Stephen Jay Gould, among others, has offered this objection. It is true that the anthropic settings of the physical constants is antecedently very unlikely. However, whatever value these constants had taken would also have been, from one point of view or another, extremely unlikely. Unlikely things happen all the time. Every time a hand of poker is dealt out, the exact constitution of the hands involved is extremely unlikely. The exact position of the molecules in this room at the present time is an astronomically unlikely arrangement.

This objection raises a fundamental problem of statistical inference: the problem of specification. If every outcome is equally unlikely, how is it that at some times we are able to exclude chance as an explanation, instead preferring the hypothesizing of some causal mechanism?

In a recent book, *The Design Inference*, philosopher and mathematician William Dembski (Dembski 1998) has offered a solution to this problem. A result is specified when it conforms to a very simple pattern, a pattern that can be specified by a simple rule or algorithm. The simpler the rule or pattern, the greater the degree of specification. When a result is very likely and very specified, no explanation is called for. For instance, if I hope that I will get a red card on the next draw, and I do get one, no special explanation is called for. Even though the result was highly specified, it was also highly likely, since I had a 50/50 chance of drawing a red card. When a result is very unlikely but has a low degree of specification, once again, no explanation is needed. If I draw a 2 of hearts, queen of spades, 5 of diamonds, 10 of clubs and 7 of spades, then this particular hand is very unlikely, but it is also relatively unspecified, since it takes quite a bit of

information to spell out this particular result. If I were to spell out in equal detail 7 different hands, each fairly undistinguished, then the event of being dealt these 7 hands, in one particular order, is astronomically unlikely, but also highly unspecified.

In contrast, suppose I am dealt a royal flush (a straight flush, ace high) seven times in a row. This is an astronomically unlikely result, and, in the context of a game of poker, also a highly specified result. It conforms to a very simple pattern: being dealt the very best hand seven times in a row. Such an outcome demands an explanation (some sort of non-random shuffling and dealing).

The anthropic coincidences are extremely unlikely. Are they also highly specified? It would seem that they are. They all fall into one simple pattern: conditions necessary for the existence of complex, molecular chemistry. If the realization of this pattern can be explained, it should be.

One might object that the pattern is in fact a very complex one, since life and organic chemistry are themselves very complex. This objection would be based on a confusion. Life is very simple in its specification (something like "self-replication carbon-based chemical systems"), but it is always very complex in its realization. The simplest forms of life that we know about have hundreds of thousands of interdependent parts, each consisting of long chains of amino or nucleic acids. It is this complexity of realization that makes life such an unlikely state for matter to be in. But the complexity of realization does not contradict the fact that the specification of life is quite simple. For example, suppose that my four-year-old son sorts 100 pictures into two piles, one a pile of pictures of living things, and the other a pile of pictures of inanimate objects. The living/non-living pattern is extremely simple, so the result is highly specified, even if each individual picture is highly complex.

2.4 The Possibility of Exotic Life

Some have objected that the anthropic coincidences involve a simple failure of imagination. We can see that life like ours, based on carbon molecules, in a universe like ours, organized around stars and galaxies, would be impossible if any of the anthropic coincidences had failed to be realized. However, this may simply overlook the possibility of very exotic life, based on radically different kinds of chemistry and physics, in very exotic universes.

First, it is not at all clear that the anthropic coincidences are really vulnerable to this charge. In many cases, it seems clear that, in the absence of the anthropic coincidences, the universe would have been so short-lived, or so lacking in interesting structure or heterogeneity, that nothing approximating the complexities of life could be possible.

In any case, even if the charge were entirely just, there still remains a remarkable coincidence in need of explanation. All we need to do is to complicate the specification of the event to be explained very slightly. What we need to explain is this: the coincidence of factors necessary for the existence of complex, carbon-based molecules.

In so doing, we are trying to explain the coincidences needed to make life like ours possible. The possible existence of exotic life is simply irrelevant to this problem. Whether or not such life is possible, we still are faced with a very unlikely and very specified event. The universe appears to be fine-tuned, not just to make life possible, but to make carbon-based life possible.

John Leslie (Leslie 1989) gives another good illustration of this fact, the story of the Fly on the Wall. Suppose we have a long stone wall. In places, the wall is entirely covered by flies. However, there is one long stretch of the wall, several hundred yards long, on which a solitary fly (and nothing else of any interest) is resting. Call this stretch the alpha segment of the wall. Suddenly, a gunshot rings out, and the solitary fly is shot. In this case, we have an event that this very unlikely (the hitting of one particular point on the alpha segment) and very specified (the hitting of a fly-occupied spot). This event calls for some sort of explanation, even though the hitting of a fly somewhere on the wall would not require an explanation, since the event of hitting-a-fly-somewhere-on-the-wall is not at all unlikely, given the presence of fly-infested stretches of the wall.

Similarly, if exotic life is in fact possible, then we do not need an explanation for the existence of life. We do, however, need an explanation of the existence of carbon-based life, since this is both highly unlikely and highly specified.

2.5 The Principle of Mediocrity & the Rejection of Anthropocentricity

The principle of mediocrity is a rule-of-thumb for the conduct of science. It requires that we assume that we, and our particular location in space and time, are nothing special. We must assume that we can observe in our own immediate neighborhood is typical of what is and what could be universally. Something like the principle of mediocrity is presupposed whenever we indulge in generalization: whenever we infer that a law of nature exists because we do not observe any violations. If we did not assume that our own space-time neighborhood is typical of the entire universe, then any generalization of our observations would be illegitimate.

The principle of mediocrity might be applied to the anthropic coincidences in the following way. We might say that the principle of mediocrity requires us to assume that all possible universes are very much like the actual universe. Since the actual universe is life-permitting, almost all possible universes must be so. But if almost all possible universes are life-permitting, then that is by itself a sufficient explanation of the anthropic coincidences.

There are at least two problems with this argument. First, the narrowness of the intervals involved (as narrow as one part in 10 to the 40th power) make it very unlikely that almost all possible universes have values that lie within the required intervals. The principle of mediocrity is a reasonable thing to presume at the beginning of our investigations, but when we discover overwhelming evidence that our own universe is very special, this evidence should override the a priori rule of thumb. Second, even if it were true that almost all possible universes are life-permitting, this does not rule out the need for an

explanation of this fact. In fact, a theistic explanation would preserve the principle of mediocrity, since a theist will hold that typical universes are life-permitting, since in most cases, God would design the universe to be so.

Another closely related principle of scientific inquiry is the rejection of anthropocentricity. This principle has become firmly engrained in scientific practice ever since the heliocentric model replaced the geocentric model. The point of the principle is to guard against a very common human bias -- that of assuming that we are more important than we are. It is natural for us to assume that we are the center around which everything else revolves, and it is essential to the acquisition of objective, scientific knowledge that we fight against this bias. The anthropic coincidences put the existence of human beings into the cosmic driver's seat, in violation of this principle.

Again, there are a couple of things to be said in response. First, the ``anthropic'' coincidences are not well-named. They should really be called the biotropic or the carbotic principle, since they concern the possibility of the existence of life, or at least, of carbon-based, planetary life. This does not put the species Homo sapiens into any special place in the grand scheme of things. It does not necessarily make the planet earth the center of the universe, since there may, for all we know, be many planets equally well-crafted for the existence of life.

Second, even if the anthropic coincidences do lead us to reject, or at least to modify, the principle of non-anthropocentricity, this seems the reasonable thing to do in light of the actual data. Once again, we cannot let a priori legislation determine in advance how we must respond to any possible data. If we find overwhelming evidence that the cosmos has been fashioned for the sake of life on earth, then we should accept this conclusion. At most, the principle of non-anthropocentricity should make us cautious about jumping too soon to such a conclusion.

2.6 Too Small a Sample Size -- Only One Universe

This objection is one first pressed by David Hume. Hume argues that we cannot draw any conclusions about the causes of a thing until we have observed many tokens of the same type. I can conclude that this egg was probably laid by a chicken only on the basis of many observations of chickens laying eggs in the past. Since we can observe only one universe, we cannot possibly be in a position to draw any conclusions about what sort of thing may have caused it.

Right away, we should concede that our situation is not an optimal one. If we could somehow observe 30 or 50 universes, each on the scale of our own, each taking very different sets of values for the fundamental constants, and yet each being structured so as to make life possible, then we would be in an optimal position to draw the conclusion that some kind of creator or designer has been at work. The question remains, however, just how far from optimal is our actual situation?

If we had to rely on only one feature of the universe, or on only two or three, we might well be in a position that warranted extreme caution. We might be wrong in our estimations of the degree of sensitivity of life to small changes in one or two parameters. However, when we have twenty-five or more features of the universe, each of which appears to be highly constrained, the basis for an inference to an appropriate explanation is much stronger.

I cannot see any basis for an absolute prohibition on reasoning from single cases. In science, history and forensics, we do sometimes come up against unique sets of circumstances. We have observed, for example, only two cases of the use of an atomic bomb against a city. Even if the bomb had been used only once, it surely would have been possible for us to attribute the death and destruction to the use of the A-bomb. Everything pointed to the activity of a fireball of intense heat, originating from a single point. Similarly, we see many signs of the activity of some agency capable of fine-tuning the features of the universe for the sake of the existence of life.

Once again, John Leslie offers a parable in support of this response, the case of the Telepathic Painting (Leslie 1989, p. 18). We are to imagine an experiment in which a purported telepath tries to duplicate a painting being produced simultaneously by another person halfway across the world. When the experiment is concluded, the two paintings are compared and found to be identical, stroke-for-stroke. Each painting contains hundreds of details, exactly duplicated in the other. In such a case, we might not accept telepathy as the explanation for the coincidence, but we would surely expect to find some explanation. The fact that we are dealing only with a single case is surely irrelevant. The single case provides by itself enough

data to warrant the search for an explanation.

3. The Theistic Explanation of the Coincidences

3.1 Teleological Explanation

What is it for something to occur for a purpose? In the last thirty years considerable work has been done on this problem by analytic philosophers, beginning with the work of Charles Taylor (Taylor 1964) and Larry Wright (Wright 1976) in the 60's and 70's. The Taylor/Wright account of teleological explanation is known as the aetiological or causal account of teleology. I will give my own version of this account, one that takes seriously the distinction between tokens and types that I have insisted on before.

First, at the level of types, I will say that type **A** occurs in context **C** for purpose **B** if and only if, whenever a token of type **(A & C)** occurs, it is most probably caused, in part, by the fact that **A**-tokens tend to cause **B**-tokens. This definition brings a causal relation in twice: first, by specifying that tokens of type **(A & C)** tend to be caused in a certain way, and second, by including the fact that **A**-tokens tend to cause **B**-tokens within the first causal connection.

A few examples may help to make the sense of the definition clearer. The purpose of saying 'please pass the sugar' is the actual passing of the sugar to the speaker. In the context of polite, English-speaking company, uttering these words does tend to cause a sugar-passing event. The fact that this is so is part of the cause of most utterances of these words. If uttering these words did not tend to cause the sugar to be passed, we would not utter them nearly so often. Similarly, the purpose of working in a coal mine, in the context of 19th century capitalist Britain, was to earn enough money to live. Working in the mine did tend to cause this result, and it is because it tended to do so that so many workers went into the mine on a daily basis. Finally, the wings of a sparrow have as their purpose the sustaining of flight. The wings tend to have this result, and the fact that they do so is part of the explanation of why sparrows have wings. Natural selection has stabilized the gene pool of the sparrows to a wing-producing state because these wings contribute causally to flight.

At the level of tokens, we need the following definition. A token **t** of type **B**-in-the-context-of-**C** has the non-accidental purpose of **B** if and only if (i) **A** in the context of **C** has the purpose **B**, and (ii) **t** was caused in part, and in the usual way, by the fact that **A**-events tend to cause **B**-events. A token of type **A**-in-**C** is very probably, but not always, a token with **B** as its non-accidental purpose For instance, (assuming Darwinism is true) the wings of the very first flying bird did not have flight as their non-accidental purpose. In that case, the wings were the product of an accidental mutation, and their contribution to the power to flight did not have any causal role in explaining their existence in this case. Similarly, if a molecule-for-molecule duplicate of myself were to form by chance in a swamp, the resulting creature would have purposive organs, but none of the tokens involved would have non-accidental purpose.

However, although accidental purpose is possible, it is very much the exception rather than the rule. Whenever we find examples of purpose, it is reasonable to assume that the purpose is non-accidental, unless we can find good evidence to the contrary.

Is there a connection between non-accidental purpose and intelligent agency? I would like to argue that there is a very tight connection: every case of non-accidental purpose is a case of intelligent agency. If some state t exists (non-accidentally) for the purpose B, then there is some intelligent agent that has B as its purpose and has produced t to this end.

The most obvious apparent counter-example to this claim is one that I have already alluded to: the products of Darwinian natural selection. The instances of purposiveness in nature produced by natural selection pass the Taylor/Wright definition of non-accidental purposiveness, and yet, according to Darwinism, there is no intelligent agent behind the adaptations. Richard Dawkins, for example, talks of Nature as the ``Blind Watchmaker'', producing well-adapted creatures without any intelligence whatsoever. According to Dawkins, the Watchmaker is ``blind'' in the sense of being unconscious, thoughtless, witless and purposeless.

However, what reason do we have to deny intelligent agency, of a kind, to Nature as Darwinism conceives of her? I don't mean to challenge the adequacy of the Darwinian story here but merely to challenge the characterization of natural selection as unintelligent and purposeless. According to Darwinism, nature does seem to act for purposes, crafting a world full of a wide variety of self-sustaining eco-systems. Darwin himself, as well as modern-day Darwinists like Dawkins and Dennett, could wax very poetic about the wonders of the designs produced by Nature, which compare very favorably to the best feats of human engineering. Why deny that Nature is a kind of intelligent agent?

There seem to be several reasons at work here. First, many point out that Nature consists of nothing but blind, purposeless forces. This is true, but to conclude that Nature as a whole is purposeless is to commit the fallacy of composition. Presumably, each of my atoms is unconscious, but this does not that my body as a whole cannot be the seat of consciousness. Second, there is the fact that Nature does not have anything like a central nervous system, and so is not able to coordinate her actions or calculate consequences in advance. This certainly has implications for the kind of intelligence that Nature has, but it does not seem to demonstrate that Nature has no intelligence whatsoever. Finally, it is a central tenet of Darwinism that Nature has no foresight. She muddles through from one generation to another, progressing only by trial and error. Again, this would mean that Nature lacks certain mental powers that we possess, but no effort has been made to show that these particular mental powers are essential to intelligent agency.

Thus, the dispute between Darwinists and special creationists should not be thought of a debate about whether living things are the products of intelligent agency, but only about what kind of intelligence and power the designer possesses. According to the Darwinists, the designer lacks the capacity for foresight, is quite limited in its ability to coordinate its actions, and suffers periodic setbacks due to interference by outside factors (such as asteroid impacts or changes in solar radiation). The Darwinist believes, not in a blind watchmaker, but only in an extremely myopic one. In contrast, the creationist believes that the designer is infinite in intelligence and power. (Obviously, a wide range of intermediate positions are possible.)

If we adopt the sort of minimalist conception of intelligent agency that I am advocating, then it can be shown that hypothesizing an intelligent creator is the only possible explanation for the anthropic coincidences. Here's a sketch of the argument:

1. The physical constants of the cosmos take anthropic values.
2. This coincidence must have a causal explanation (we set aside for the moment the possibility of a chance explanation through the many-worlds hypothesis).
3. Therefore, the constants take the values that they do because these values are anthropic (i.e., because they cause the conditions needed for life).
4. Therefore, the purpose of the values of these constants is to permit the development of life (using the aetiological definition of purpose).
5. Therefore, the values of these constants are the purposive effects of an intelligent agent (using the minimalist conception of agency).

6. Therefore, the cosmos has been created.

The crucial step in the argument is the third one. Once we reach the conclusion that the values of the fundamental constants exist because they are anthropic, some form of theism quickly follows. Why think that any form of explanation for the anthropic coincidences must suppose that these coincidental values exist because they are anthropic? The reason is this: any other hypothesis will fail to explain why the values are >anthropic. If, for example, we were able to deduce all of the anthropic values of the fundamental constants from some very simple, all-encompassing Grand Theory of Everything, we would still be faced with a new form of anthropic coincidence: explaining why the actual laws of nature force all of the constants to take anthropic values.

Here's an analogy to illustrate the point. Suppose that we discovered that, hidden within the background radiation pervading the universe, is an encoded version of the proof of a famous theorem, like Gödel's incompleteness theorem. This encoded signal would constitute a remarkable coincidence, requiring some explanation. Suppose further that we were able to prove that the signal exists in the radiation because it was first encoded into the form of the laws of physics. This would not solve the puzzle -- it would only relocate it. Now we would want to know how this information came to be encoded in the laws of physics. Similarly, if the values of the constants are constrained to take anthropic values by the fundamental laws of physics, then these laws themselves are fine-tuned to produce this result. In fact, the coincidence is now greater, in more need of theistic explanation, since it is even more unlikely that the laws of physics would by chance form an elegant system that happens to determine all of the values correctly than that the individual constants should each take the correct value by chance. In fact, discovering an elegant theory that generates all the anthropic values would provide conclusive evidence for theism, since this is a result that the many-worlds hypothesis could not explain. The combination of elegance and anthropicity would be a coincidence demanding explanation in terms of purpose.

Notice that at no point does this argument appeal to any supposed similarity between the setting of the values of the constants and any work of human craftsmanship or design. The argument is not based on extending our experience of the origins of human artifacts to the origins of the universe. In fact, I would go so far as to claim that **it would be possible for someone to recognize the existence of intelligent agency for the first time by studying the anthropic coincidences**, without ever having recognized the phenomenon of human agency. I would like to propose that we could invert Paley's famous analogy of the man who encounters a watch in the desert and infers that it was designed. Let us imagine a person, The Stranger, who lives in Robinson-Crusoe-like isolation, and who is very un-self-conscious. The very ideas of purpose or intelligence or agency have never occurred to the Stranger, who has instead spent all of his time studying the physics and cosmology of the world. One day, the Stranger discovers the anthropic coincidences, and assuming that they must have a causal explanation, finds that he is forced to introduce a new kind of explanation into his science, one in which a state can be caused, in part, by the tendency of that state to cause some further effect. The Stranger calls this new kind of causal explanation ``teleological explanation''. The

Stranger also adopts a term for the underlying cause of a purposive state: ``intelligent agency".

Years later, the Stranger discovers the existence other humans and wanders into a watchmaker's shop. Looking over the shoulder of the watchmaker at his craft, the Stranger cries ``Eureka! What I am seeing is strangely reminiscent of the intelligent agency I discovered as the cause of the anthropic coincidences. Apparently, this hairy, bipedal creature is some sort of intelligent agent, and the metallic object he is producing must serve some purpose!"

3.2 The Simplicity of Theism

The design argument for theism is successful only if theism is a simple hypothesis. Swinburne (Swinburne 1987) argues that classical theism is a very simple hypothesis, since it uses only simple quantities, namely, zero and infinity. A hypothesis positing the existence of a being with infinite power and intelligence, that is, a being with zero limitations to his power and knowledge, is simpler than any hypothesis involving a finite deity. Critics of the design argument, including Hume and Mackie, have argued that theism is covertly complex, since the realization of intelligent agency requires a great deal of complexity. This objection can be divided into two arguments: the big giant brain objection, and the duplication objection, both of which can be found in Hume's *Dialogues Concerning Natural Religion*.

The Big Giant Brain objection goes something like this. Every intelligent agent we know of (humans, maybe chimps and whales) have highly complex central nervous systems, with billions of neurons and quadrillions of connections. A god who is highly intelligent, therefore, most probably has a brain that is much larger and more complex than a human brain. An infinitely intelligent god would seem to require an infinitely large brain. This means that theism involves introducing more complexity, more amazing coincidences and purposively organized structures, than was present in the data it is designed to explain. Consequently, the prior probability of theism is even lower than the probability that the cosmos became organized anthropically by chance, and so the anthropic coincidences do not make theism more likely true than false.

As I have argued above, it is not clear that all intelligent agents have central nervous systems. If Darwinism is true, then the earth's biosphere is an intelligent agent, designing the earth's living creatures through a process of trial-and-error learning. In any case, the teleological version of the design argument does not lead to the conclusion that God, the intelligent agent behind the anthropic coincidences, is in any way similar to human beings. In fact, we have good reason to believe that He is radically different from us. This means that we have little grounds for extending a generalization based on finite agents to an infinite agent. For this Humean argument to work, the objector must spell out some reasons for believing that any intelligent agent must have a brain.

In exploring this question, it might be helpful to reflect on what we know about our own case: why do we humans need a brain? For the sake of argument, I will assume that we

accept a fairly strong principle of the dependency of the mind on the brain. There would seem to be five roles that the brain plays in making possible intelligent agency in humans:

1. As the site of internal representations of our desires, drives and valuings.
2. As the site of internal representations of our sensory perceptions and memories (our knowledge of the actual world).
3. As the site of internal representations of alternative possibilities.
4. As the site of internal representations of our plans, intentions and volitions.
5. As the basis for processes of ratiocination, inference, and other forms of information processing.

Let us consider how many of these considerations would apply to an infinite agent. First, the traditional view of God's intelligence has been that God's thought is "non-discursive". This means that God does not think in anything like English sentences. Consequently, God does not need to indulge in deductive reasoning, such as syllogistic reasoning. Instead, God's knowledge encompasses both possible and actual situations in their complete specificity, without any linguistic or conceptual intermediary. God never has to reason as we do, "All men are mortal, Socrates is a man, therefore Socrates is mortal." God sees both the humanity and the mortality of Socrates (and of each individual man) immediately. Similarly, God never needs to indulge in inductive or probabilistic reasoning, since there are no gaps in His knowledge to be filled by such inferences. Thus, an infinite agent would not need a brain for the purpose of #5 above.

Reasons #1 through #4 bring us to the second objection to the simplicity of theism: the duplication objection. Whether or not God needs a brain, the size, number and complexity of God's internal representations would be great, far greater than the complexity of the cosmos His existence is supposed to explain. All the complexity of the universe is duplicated in the form of a representation or plan for the universe in God's mind. The plan in God's mind could explain the anthropic coincidences in the universe, but what can explain the anthropic coincidences realized by the plan itself, qua representation in God's mind?

This is a serious objection. I think that the best theistic response is to challenge the idea that an infinite mind needs representations at all. I call the resulting model of the divine mind the ``non-discursive, non-representational model''. Instead of re-presentations, God can make use of presentations, the immediate presence of the objects of God's thought to God's mind. Let us suppose, for the moment, that we all accept the existence of three kinds of things: (i) the actual, spatio-temporal world and all of its constituents. (ii) a space of possibilities, ways the world could have been, some partial and some total in their scope, and (iii) objective, intrinsic values that attach to each possibility, consisting of the degree of goodness or badness that would be realized if that possibility were made actual. Let us suppose further that each of these kinds of things is immediately present to God's mind, as immediately present to God as our own internal representations are to us.

If these three kinds of things exist, then there is no need for internal representations in God's mind corresponding to #1 through #4 above. God consults the various possibilities directly, without needing to make a copy of them within His own mind. To some of these possibilities are attached a high degree of intrinsic value, and this fact is immediately available to God, without any need for an internal representation of His own desires or values. The actual states of affairs, whether the result of God's own direct willing or the result of the agency of created things, are also directly apparent to God, without need for anything like sense organs and attendant nervous systems. The only thing that theism adds to the existence of these three kinds of realities is a power of determination, corresponding to our own power of will or choice. This power of determination selects one of the possibilities with a high enough level of intrinsic value and actualizes this possibility. If this possibility involves the existence of created agents with their own powers of determination, then subsequent acts of divine determination may be necessary, in response to the evolution of the created order.

If we doubt the existence of unrealized possibilities or objective values, then theism would involve the addition of complexity to our picture of the world. However, there are strong grounds for accepting both of these kinds of reality, grounds that are independent of the case for or against theism. In the final analysis, one's assessment of the simplicity of theism is going to depend to some extent on one's background metaphysical theory. People who accept, on independent grounds, the reality of possibilities and values (modal and ethical realists) will find theism much simpler than do those who reject the reality of these things.

Is the divine agent who emerges from the design argument, when combined with the non-discursive, non-representational model of the divine mind, a divine person? Certainly, if God is a person, He is a person of a radically different kind than we are. Moreover, there are many features of personhood for which we have not found compelling arguments. We have said little about the presence of consciousness in God, beyond that form of consciousness that is essential to awareness or knowledge. We have said nothing about feelings or emotions in God. We have not gained much insight into the nature and scope of God's purposes. We do not yet know whether they have the complexity and internal coherency that we would expect to find in a personal agent. In conclusion, we should say that, although nothing we have found excludes the possibility of a personal God, the design argument, in and of itself, provides us with no grounds for attributing a rich personality to God.

At the same time, the anthropic coincidences clearly indicate that God is highly intelligence, with a great deal of foresight (the feature conspicuously absent from the Darwinian watchmaker). Moreover, we can plausibly assume that God's purposes include the creation of things of a high degree of intrinsic value, with which we can include the creation of life.

4. The Many-Universes Model

The only real competitor to the theistic explanation is the Many-Universes model. According to the Many-Universes model, there are a very large number of parallel universes (perhaps infinitely many) out there, with the values of the fundamental constants varying randomly from one universe to the next. Only an infinitesimally small proportion of these universes are (by chance) the kind of place in which life is possible, but it is not surprising that we are in one of those universes, since otherwise we wouldn't be here to ask the question.

There are several things to be said in response.

4.1 Metaphysical Parity of Theism and Many-Universes

Note how the situation has changed. Originally, atheists prided themselves on being no-nonsense empiricists, who limited their beliefs to what could be seen and measured. Now, we find ourselves in a situation in which the only alternative to belief in God is belief in an infinite number of unobservable parallel universes! You've come along way, baby!

At the very least, God's existence is as good, as simple and economical an explanation of the coincidences as is the many-universes model. Arguably, it is much simpler, in fact.

4.2 Tie Breakers

The Many-Universes model has been invented solely to explain the coincidences. It is what science calls an "ad hoc" explanation. There is no other, independent evidence of the existence of these other universes. For example, there is the cosmological argument, about which I have written elsewhere (Koons 1997). In addition, there are arguments for God's existence from morality, consciousness, religious experience and the possibility of knowledge (see Swinburne, Adams, Alston, Plantinga).

4.3 The Supererogatory Goodness of the Universe

The Many-Universes model cannot explain why the values of the constants in our universe are not merely good enough but actually optimal, perfect. In particular, our universe has an extraordinarily long life compared to most hypothetical universes, and life has arisen at a very early stage in the life cycle of the universe (indeed, in a very early stage in the life cycle of our sun). Philosopher Robin Collins at Messiah College has recently published a proof that in the Many-Universes model, we should expect that life would arise only at point very near the end of the life cycle of the associated star. The fact that life arose so early on the earth is strong evidence that our universe has been optimally designed for the origin of life.

In addition, the Many-Universes model cannot explain the consistent thread of simplicity, elegance and symmetry that run through the laws of nature. In contrast, this aesthetic consistency is just what classical theists, beginning with Plato in the Timaeus, have always predicted.

4.4 Leslie's "Further Evidence"

As John Leslie points out, many of the fundamental constants have to take the values they do for several independent reasons:

A force strength or a particle mass often seems to need to be more or less exactly what it is not just for one reason, but for two or three or five. Yet obviously it could not be tuned in first one way and then another, to satisfy several conflicting requirements. A force strength or a mass cannot take several different values at once! So, you might think, mustn't it be inexplicable good fortune that the requirements which have to be satisfied do not conflict?.....
"I suspect that we ought to be thinking in terms of hugely many possible Fundamental Theories. In most cases these Theories would make living things impossible because, alas, the existence of such beings would demand that such-and-such factors be fine tuned in conflicting ways. Perhaps only extremely rarely would any Fundamental Theory -- any Theory of Everything whose equations might be written on the back of an envelope or an elephant --- avoid this depressing result. But some small group of Theories would avoid it, and the Creator would be guided by this fact. (Leslie 1989, pp. 64-5)
This fact makes it quite remarkable that a single range of values could satisfy more than one anthropic constraint. When the value of a single constant is constrained in more than one way, it would be very likely that these independent constraints put contradictory demands on the value of the constraint. By way of analogy, if I consider several algebraic equations, each with a single unknown, it would be very surprising if a single value satisfied all of the equations. Thus, it is surprising that a single range of values satisfies the various anthropic constraints simultaneously. Leslie argues that this higher-order coincidence suggests that the basic form of the laws of nature has itself been designed to make anthropic fine-tuning possible. In other words, Leslie argues that there is evidence of a higher-order fine-tuning.

Theism can explain this higher-order fine-tuning, since presumably God designed the basic form of the laws of nature, and did so in such a way as to make anthropic fine-tuning of the physical constants possible.

Can the many-worlds hypothesis explain the higher-order fine-tuning. It can, but only if we suppose that the basic form of the laws of nature varies randomly from one universe to the next. If we combine this assumption with the assumption that there is a virtual infinity of alternative universes, then observer selection can explain why the basic form of the laws of the universe is fine-tuned.

However, the price to be paid for such a super-many-worlds hypothesis is quite high. It is a fundamental maxim of the scientific method to assume that the basic form of the laws of nature is uniform, that what we observe in our own neighborhood is typical of all of reality. If we abandon this maxim, then all inductive or scientific learning becomes impossible. If the laws of nature vary randomly from universe to universe, then we have good reason to believe that the laws of our own universe are very complex, not at all simple, no matter how much evidence of apparent simplicity we observe. The number of

universes with complex laws of nature is much greater than the number of universes with simple laws. No matter how much data we collect, and no longer how simple the curve to which the data can be fit, there are infinitely many more complex curves passing through the data points than there are simple curves. This means that we would never be justified in inferring the existence of simple laws of nature. The super-many-worlds hypothesis would pull the rug out from beneath the scientific enterprise.

4.5 Highly Fine-tuned versus Coarse-Tuned Universes

An additional argument for theism depends on the distinction between highly fine-tuned and coarse-tuned universes. Anthropic universes presumably fall into a range: in some cases the range of permitted values around the actual value is extremely narrow, and in other cases the local range is much wider (relatively speaking). The first kind of anthropic worlds I call ``highly fine-tuned", and the second kind I call ``coarse-tuned". A region of contiguous highly-fine-tuned universes is a highly fine-tuned region, and a region of contiguous coarse-tuned universes is a coarse-tuned region.

Let us assume that the number of highly fine-tuned regions is approximately the same as the number of coarse-tuned regions. By definition, the coarse-tuned regions are each much larger, containing far more worlds, than the highly fine-tuned regions. Consequently, the typical anthropic world is a coarse-tuned world. Highly fine-tuned worlds are atypical cases of anthropic worlds.

If we find evidence that our universe is a highly fine-tuned universe, this would be a very unlikely occurrence that could not be explained by observer selection, since most worlds in which observers occur are coarse-tuned. If this unlikely occurrence were also specified, then it would be something that would require a causal explanation. I would argue that being a highly fine-tuned world is clearly a specified event, since we can pick out the class of highly fine-tuned universes by a very simple description, without any post hoc reference to actual events

If our universe is highly fine-tuned, this fact could be explained by theism. God might have a preference for creating life under circumstances that demand a high order of intelligence and foresight. Traditional theology includes the claim that God created the world for the sake of his own greater ``glory". The successful carrying-out of a project of fine-tuning would make a greater contribution to the glory of the creator than the completion of a coarse-tuned universe.

As we discover more and more evidence of the fine-tuning of our own universe, the probability grows that our universe is highly fine-tuned, and not merely coarse-tuned. Theists can predict that still more anthropic coincidences will be found, a prediction that the many-worlds hypothesis cannot duplicate.

Recent work on computer simulations of the spontaneous development of life, including the so-called "Game of Life", provides evidence that our own universe is highly fine-tuned. These computer simulations provide evidence for the existence of coarse-tuned

universes, universes in which the laws of physics and chemistry are, unlike those in our actual universe, robustly conducive to the existence of life (self-replicating systems). These simulated universes include physical states that take only discrete values (like on/off), in contrast to the continuous nature of the actual physical world. This discreteness makes life much easier to create and sustain under a variety of conditions, unlike the conditions in the actual world.

As we discover more instances of fine-tuning, the relative probability of theism over the many-worlds hypothesis is increased for two reasons. First, as we have seen, the existence of more instances of fine-tuning increases the probability that our universe is highly fine-tuned, a fact that theism, but not the many-worlds hypothesis, can explain. Second, as the degree of fine-tuning increases, the many-worlds hypothesis must posit an exponentially increasing number of parallel worlds. Theism, in contrast, can explain any degree of fine-tuning without any material modification of the hypothesis. As the number n increases, the probability that there are at least n worlds decreases. This decrease in probability makes it increasingly unlikely that the many-worlds hypothesis is the correct explanation of the coincidences.

4.6 Many-Universes Itself Requires a Theistic Explanation

Suppose that we accept the many-universes hypothesis and use observer-selection to explain the existence of anthropic values in our universe. There is still one remarkable fact for which we have no explanation: why there exist a sufficient number of universes to make the existence of life unsurprising. If a few million or billion worlds were enough, this would perhaps not be too surprising. However, the anthropic coincidences would require that a mind-bending number of universes exist, something on the order of 10 to the 200th power. If we consider all possible forms that reality might take, it can seem quite surprising that we find ourselves in a version of reality with such a plenitude of universes.

Theism can offer some plausible explanations of this fact. First, as Leslie argues, we could easily imagine that God has a strong preference for variety for variety's sake. This would give God a good reason for creating an infinity of universes, in which physical and cosmological constants take every possible value. Second, God might have had in mind creating such a large ensemble of universes that interesting things, like life, would be bound to happen in at least a few of them by chance alone.

As Leslie points out, theism and the many-worlds hypothesis are not logically inconsistent. If there is only one universe, then the anthropic coincidences point to the existence of God. Alternatively, if there are many universes, this fact too supports theism.

5. Conclusion

If physics and cosmology have led us to a revival of the argument from design, legitimating references to the activity of an intelligent creator of nature, this fact has implications for the practice of other sciences and disciplines. In a recent book, Michael

Denton (Denton 1998) brings a design perspective to chemistry, geology and biology. Michael Behe (Behe 1996) has argued that the existence of intricate molecular machines provide examples of "irreducible complexity," which can best be explained by intelligent agency and not by undirected mutations. Similarly, research on the origin of life may be overdue for some fundamental rethinking. In recent years, science has been wedded to a philosophy of materialism. The time has come for a trial separation, at the very least.

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