Intelligent Design:
The New Stealth Creationism

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Nature is what the world would be if there were no God.

-William Dembski

Intelligent Design is the name used by the latest attempt to incorporate teleological explanations as part of science. The claim is made that *scientific data* cannot be understood naturally but require the additional element of purpose, divine or otherwise. In the minds of at least some if its proponents, the evidence in support of their position has become so strong that they propose, in the name of fairness, that it should become part of science texts and be taught in the science curriculum.[1] However, as I will show, intelligent design arguments are little more than new variations on the ancient argument from design.[2] While the proponents of Intelligent Design are generally not biblical literalists or Young Earth Creationists and accept most of what modern physics and cosmology sat about the cosmos, they still insist that that cosmos had to be the result of some outside agent—based on scientific arguments. The intelligent design movement is a kind of *stealth creationism*, creationism by another name.

The argument for design to the universe is, of course, ancient. What is new here is the wrongful claim that this philosophical and theological argument is now supported by science. Several elements of intelligent design can be identified. These are listed first here with a brief explanation and a short summary of my conclusions. The names of individuals who are primary reference sources of each notion are indicated; however, this should not be taken to imply that each would agree with all the implications that have been attributed to their ideas, by me or anyone else, which of course should be read in the original. Not all will be discussed, and this is not intended as a complete review or rehash of all that has been written already on the subject. Instead several points are made that I have not seen discussed in the literature.

Information Theory (William Dembski):

Mathematician, philosopher, and theologian William Dembski claims to have proven, from modern information theory, that the kind of information inherent in the universe cannot be generated by natural causes.[3] As I will show, his proof amounts to nothing more than the usual misinterpretation of the second law of thermodynamics made by creationists. It is not only old; it is also wrong.

Irreducible Complexity (Michael Behe):

Biochemist Michael Behe asserts that biological systems exist that cannot have evolved from simpler forms.[4] This notion has been widely discussed and I will not say anything further about it here.[5] I wish to focus on arguments from physics and cosmology rather than biology.

Anthropic Coincidences (John Barrow and Frank Tipler)

Physicists John Barrow and Frank Tipler have collected a large number of examples in which the laws and constants of nature seem to be fine-tuned for the production of life as we know it on earth.[6] This has been interpreted by theists as meaning that our universe shows signs of divine purpose, with humanity, or at least bacteria, as that purpose. However, this argument fails to consider the possibilities of life forms quite different from our own that could exist in a different universe with different physics.

Furthermore, current cosmological theories do not rule out and, indeed, strongly suggest the existence of many universes besides our own. Even if these possibilities cannot be proved, the fact that they cannot be disproved is sufficient to refute the fine-tuning argument.

Modern Platonism (Roger Penrose and Paul Davies)

The late, great physicist Eugene Wigner commented on the "unreasonable effectiveness of mathematics" in describing the physical universe. Some mathematicians and scientists have suggested that this implies a Platonic reality beyond the senses, one that does not necessarily imply theism but one that suggests far more than meets the eye. However, while the existence of a Platonic reality cannot be ruled out, arguments from simplicity and symmetry strongly prefer the universe we see, with eye and instrument, and have successfully described in physics theory without anomaly. This reality is composed of particulate atoms moving around in an otherwise empty void.[7]

Big Bang Creation (William Lane Craig)

Christian philosopher William Lane Craig has modernized the ancient Islamic *Kaläm cosmological argument* that the universe had a beginning and so must have been created.[8] He takes the cosmological big bang as evidence of a beginning to our universe. However, as a theist he is forced to admit that an uncreated entity can exist, namely God, who had no beginning. I argue that we have no scientific basis to assume the universe had a beginning. In fact, fundamental physics shows no preferred moment or direction of time.[9] From Craig's own logic, it then follows that the universe need not have been created.

Now for the details.

Complex, Specified Information

In his 1999 book *Intelligent Design* and other publications, William Dembski asserts that he can *prove*, from modern information theory, that life and, indeed, the universe, cannot possibly be the result of natural processes and chance.[10] Thus, the argument from design dons yet another set of clothes. However, as we will see, these new duds

are almost as transparent as the Emperor's, scarcely hiding the naked creationism that lies below.

Dembski derives what he calls the *law of conservation of information*. He argues that the information contained in living structures cannot be generated by any combination of chance and natural processes. Neither mechanism, he insists, is capable of increasing information.

Dembski is inconsistent in his use of the term "information." In his words he implies the common understanding of information as a measure of knowledge about a system. However, when he uses mathematics he defines a quantity of information that is exactly identical to what in information theory is called *Shannon uncertainty*,[11] usually denoted by H:

$$H = -\sum_n P_n \log_2 P_n = -\langle \log_2 P_n \rangle \qquad (1)$$

where P_n is the probability for the system to be found in a configuration n and the sum is over all possible configurations. The angle brackets refer to the average.

Thus H equals the number of bits that are needed to transmit a signal communicating that configuration, irrespective of the content of the message. In the special case where $P_n = P$ for all n, $H = -\log_2 P$, which is the form Dembski uses for his measure of information.[12]

A more conventional definition of information that is consistent with the vernacular use of the term is $R = H_{before} - H_{after}$, the *decrease* in Shannon uncertainty under the action of some process. If $R > 0$, information has been gained and fewer bits are now needed to describe the system.

In any case, the confusion of sign is not important—just a matter of definition. More important is Dembski's "law of conservation of information," which states that the number of bits H cannot change in any natural process such as chance or the operation of some physical law. As he explains it, "chance and laws working in tandem cannot generate information."[13]

For example, suppose we toss five fair coins in the air. The probability of any specific resulting sequence, say HTTHT, is $(1/2)^5$. The Shannon uncertainty (Dembski

information) contained in that sequence is $H = -\log_2 (1/2)^5 = 5$. That is, it can be represented by the five bits 10010. (I chose a particularly simple example).

No information is gained in this random process. Whatever the initial arrangement of the coins prior to their toss, it also contained five bits of information. However, what about a sequence such as HHHHH? Intuitively it seems that it contains more information than HTTHT. But it does not. In either case, $H_{after} = H_{before} = 5$ and $R = 0$. However, if we pick up two of the coins (an "act of design," Dembski would say), $R = 2$ bits of information have been gained.

Suppose we specify the sequence HHHHH in advance. Then we have five bits of what Dembski calls *specified information*. We can just as well specify HTTHT, as long as we do this ahead of time or identify some other characteristic of the sequence that marks it as something other than a random occurrence.

Now, five heads in a row, or any specified sequence of five coins, can happen by chance. On average, about one of every thirty-two tosses of five coins will land with all five heads up. However, suppose we do the experiment with 500 coins instead of five and specify that all fall heads up. This would require $2^{500} = 10^{150}$ tosses of 500 coins each, again on average, to obtain 500 heads by chance. Dembski rightly says this is, for all practical purposes, impossible. Even tossing at the rate of once every 10^{-43} second, the smallest measurable time interval (the Planck time), it would take 10^{100} years to do this many tosses. Each of the 10^{88} particles in the visible universe doing the experiment simultaneously would take a trillion years to find one case of 500 heads up. Dembski defines 500 or more bits if information as *complex* and argues that the observation of *complex specified information (CSI)* in the universe is evidence for intelligent design. In particular, biological evolution cannot be simply the product of chance and natural law.

Dembski does not define specificity as precisely as he does information and complexity. In the coin example I gave above, the sequence is specified in advance. However, he cannot leave it at that because then his whole program to detect design after the fact would be defeated. So, as a dubious and dangerous alternative, he allows specificity to be post-determined. An observed sequence might contain some message that is too unlikely to be chance. He uses an example from the film *Contact*, based on Carl Sagan's novel, in which Jodie Foster detects an intelligent signal from outer space

containing the sequence of prime numbers up to 101. Although specificity is rather difficult to define, like pornography you know it when you see it. Dembski's far more dubious claim is that complex specified sequences of information cannot happen naturally. In fact, it is more than dubious. It is simply wrong.

Dembski claims to prove that the generation of *any* information by natural processes and chance is impossible—not just complex specified information. Since the universe contains information, that information must have come about by other means that he labels intelligent design. While he insists that this argument does not depend on any specific theological assumptions, his book unabashedly promotes his interpretation that the design inferred is the work of the Christian god. Indeed, the whole Intelligent Design movement is being more than a bit disingenuous when it claims that it has no religious agenda.

The Second Law and Natural Order

In statistical mechanics, physicists define the entropy of a system as $S = - k \sum_n P_n \log_e P_n$ where P_n is the probability of the system being in a state n and k is Boltzmann's constant. Except for units and the different base of logarithms, we see that Shannon uncertainty and entropy are identical. In fact, $S = (k \log_e 2) H$. Indeed, Shannon referred to his quantity H as "entropy," just expressed in bits rather than the Joules per Kelvin units of conventional physics.

As is well known, entropy is a measure of "disorder." The Shannon uncertainty is likewise a measure of the randomness in a signal, applied in communication theory. Since the opposite of disorder is order, we associate order with negative entropy or *negentropy*. Positive information gain R, as in the previous section, is then associated with an increase in order.

In physics, the second law of thermodynamics specifies that, on the macroscopic scale of many-body processes (an assumption not always made explicit in lower level text books), the entropy of a closed system cannot decrease. Although Dembski does not admit this in *Intelligent Design*, his law of conservation of information is nothing more than "conservation of entropy," a special case of the second law that applies when

no dissipative processes are present. In fact, entropy is created naturally a million times a day by every human being in earth, each time any friction is generated. Rub your hands together right now and make some entropy.

Let me give a simple, quantitative example—the free expansion of an ideal gas covered in freshman physics. If the initial volume of the gas is V_i and the final volume V_f, then the entropy change is $\Delta S = Nk \log_e (V_f / V_i)$, where N is the number of molecules of the gas. Suppose the gas expands to twice its initial volume. Then $\Delta S = Nk \log_e(2)$, or $\Delta H = N$ bits, from which we see that the information decreases (disorder increases) by an amount N bits. Clearly, Dembski information, it is not conserved in this simple, natural process.

When Dembski says that information cannot be generated naturally, he seems to be voicing yet another muddled version of the common creationist assertion that the second law forbids the generation of order by natural processes. Like his predecessors, he ignores the caveat "closed system" (or "isolated system" to chemists,who use the term "closed system" differently from physicists) in the formal statement of the second law. Open systems can and do become more orderly by their interaction with other systems. For example, the earth is ordered by the action of energy from the sun. In the process, both the sun and earth lose entropy; but this is compensated by a corresponding gain in the total entropy of the universe, which is the closed system for this purpose. The sun provides for the generation of order on earth, including that contained in living organisms.

Whenever a drop of water freezes into an ice crystal we observe the creation of order by a "mindless" natural process. We don't need fancy information theory to tell us that. We can see it with our own two eyes.

Was the Creation of the Universe a Miracle?

If we hypothesize that the universe is a closed system, meaning nothing in and nothing out, then both the first and second law of thermodynamics would seem to have been violated at the "creation." The first law is equivalent to energy conservation, and a reasonable question is, "Where did the current matter and energy of the universe come from?" As best as we can tell from current observational data, the total mechanical

energy of the universe is zero with the positive kinetic energy of motion exactly balanced by the negative potential energy of gravity. As for matter or mass energy (the rest energy of bodies), the inflationary big bang cosmological model allows for this to be generated during the early expansion of the universe during which the pressure of the vacuum is negative and the universe does work on itself, as allowed by the first law. This negative pressure is supplied by the cosmological constant term in Einstein's equations of general relativity.[14]

The second law of thermodynamics would seem to require that the universe began in a state of low entropy and is evolving toward a final state of ultimately maximum entropy, the so-called "heat death." Thus, theists have argued, even if local order can occur naturally, supernatural design is evident in existence of the highest level of order at the creation.

This argument had great weight in the nineteenth century, when the universe was regarded as a firmament of fixed stars However, we now know that the universe is expanding. As it expands, its maximum allowable entropy increases leaving increasing room for order to form.

This can be easily understood from the following mundane example: Suppose, every day you empty your kitchen trash can into your yard. Pretty soon the yard will have no room left for trash. So you buy up the surrounding property and start dumping there. As long as you keep that up, expanding your property perimeter, you can always make your house more orderly by simply dumping your rubbish (entropy) to the outside.

The universe is like that. As long as it keeps expanding, and we now have good reason to think that this will go on forever, we always have a place to toss out our entropy as we organize ourselves locally. Whether we will always have sufficient energy to do this is another question I will not address here.

Since the universe is now expanding, we can extrapolate it back in time to when we might suppose it was a sphere 10^{-35} meter in diameter, the *Planck length.* At this time, the universe was indistinguishable from a black hole of the same size. Since a black hole has maximum entropy for an object of its size, it follows that the universe had maximum entropy when it was a Planck sphere. At that moment it was as

disorderly as it could possibly have been. It was without order—without design. If a creator existed, any information she may have inserted into the universe prior to that time would have been lost.

In short, no miracle—no violation of any known principles of physics—was required to produce the universe. Indeed, the data would suggest the opposite, with the parameters of the universe appearing to be exactly what would be expected if design were absent.

Fine Tuned for You and Me

In a 1998 cover story, *Newsweek's* Sharon Begley reported that "Physicists have stumbled on signs that the cosmos is custom-made for life and consciousness."[15] To Christian physicist Hugh Ross, this recent turn in research is "sufficient to rule out all theological options but one—the Bible's." He argues that these results make any conclusion other than an intelligent, *personal*, creator impossible.[16]

The fine-tuning argument is based on a series of scientific facts called the *anthropic coincidences.*[17] As the argument goes, if the universe had appeared with slight variations in the strengths of the fundamental forces or the masses of elementary particles, that universe would be pure hydrogen at one extreme, or pure helium at the other. Neither would have allowed for the eventual production of the heavy elements such as carbon or silicon necessary for life.

Similarly, if gravity had not been many orders of magnitude weaker than electromagnetism, stars would not have lived long enough to produce the ingredients of life. Long before they would be able to fabricate chemical elements, stars will have collapsed. Only the fact that the gravitational force was forty orders of magnitude weaker than electromagnetic forces prevented this from happening.

Ross lists 26 parameters that have to fall within narrow ranges "for life of any kind to exist."[18] There are probably more since that writing. These range from the strength of the strong nuclear force to the ratio of exotic to ordinary matter.

Ross makes a serious logical error, however, repeating the expression "any kind of life" several times, while estimating various extremely low probabilities for the combinations needed for our *particular* form of life.

The anthropic coincidences are claimed as evidence for a universe that was created with humans in mind. Oxford mathematician Roger Penrose has estimated that the probability of a universe with our particular set of physical properties is one part in one followed by 10^{123} decimal places.[19] He shows a cartoon of the Creator pointing to a single point in a phase space (an abstract space in which each state of a system is a point) than contains this many possible points. However this is not the full story. No one knows how many other points in Penrose's phase space will allow for the formation of *some* kind of life. It could be all of them, and although I doubt it, no one knows enough to rule this out.

If we properly compute, based on our actual knowledge rather than speculation, the probability for the universe's existing with human life, the result is unity! We have only one datum, our universe, and it has human life. On the other hand, the probability that one particular universe chosen from a random set of possible universes would be our particular universe is a different question. And the probability that one of a random set of universes is one that supports some form of life is a third question. I submit it is this last question that is the important one and that we have no reason to expect that this probability is small.

I have made estimates of the probability that a chance distribution of physical constants can produce a universe with properties sufficient that *some* form of life would have, in all likelihood, had sufficient time to evolve.[20] In this study, I assumed the same laws of physics as exist in our universe, since I know no other. Who knows how many other universes with different laws can still produce life? That only adds to its likelihood. According to our universe's well-established laws, the values of three fundamental constants are sufficient to determine the gross physical properties of matter, from the dimensions of atoms to the length of the day and year and, most important for our purposes, the average lifetime of main sequence stars. One of these constants is the strength of the electromagnetic interactions. The other two are the masses of the electron and proton.

Of course, many more constants are needed to fill in the details of our universe. Varying the constants that go into our familiar equations still will give many universes that do not look a bit like ours. The gross properties of our universe are determined by

these three constants, and we can vary them to see how a universe might appear when the values of these constants are altered.

I find that almost all combinations of physical constants lead to universes, albeit some strange ones, that would live long enough for some type of complexity to be likely to form (see figure 1). Over half the universes contain stars that persist longer than 1 billion years.

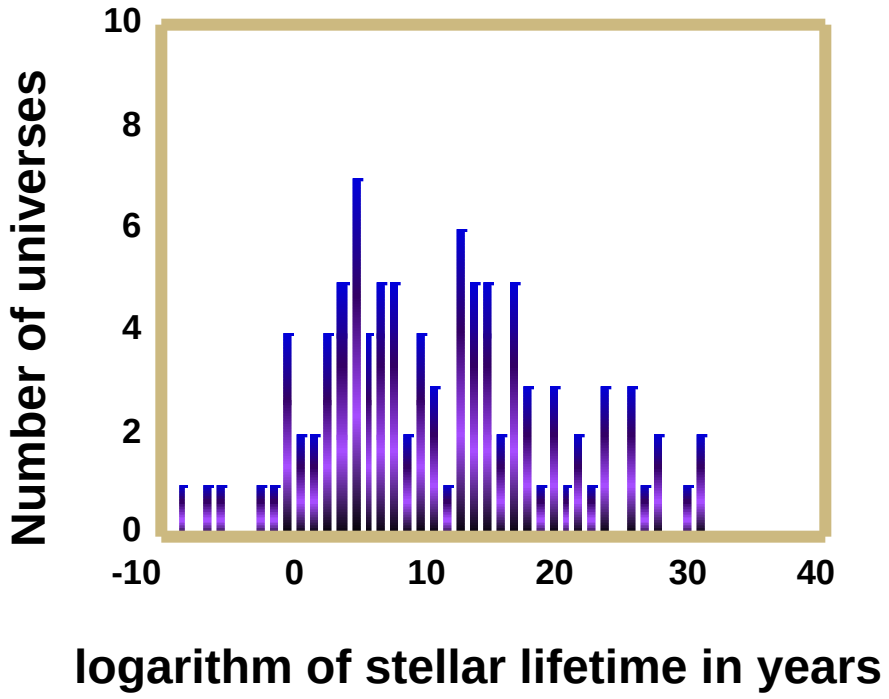

Figure 1 . Distribution of stellar lifetimes for 100 random universes.

The God of the Equations

Now let me imagine that creationists buy all these arguments and accept that the anthropic coincidences can be explained naturally, that is, in terms of known physical principles. Whenever the assertion is made that a spontaneous, uncaused "creation" violates no known physics, the theist will say, "Where did physics come from?" They and sympathetic scientists argue that the very existence of those principles themselves

provide evidence for a Platonic order to the universe that transcends the universe of our observations. This is also a very old idea to which new wrinkles have been added in recent times.

Stephen Hawking's biographer Kitty Ferguson alleges that the famous Cambridge cosmologist has replaced the older pantheist notion of God as the "embodiment of the laws of physics" with a more precise description: "The laws of physics are the embodiment of a more fundamental 'rationality'—to which we could give the name 'God'." [21]

Recent trends in Christian theology and its claimed *rapprochement* with science have moved Christianity closer to a position where the nature of deity is to be found in the order of nature. The Christian God is still a creative entity transcending space, time and matter. However, the latest notion of God is probably closer to Plato's Form of the Good than the white-bearded Jehovah / Zeus on the Sistine chapel ceiling or the beardless Jesus / Apollo on the wall.

And here is where some scientists and theologians currently seem to find their common ground—in the notion that ultimate reality is not to be found in the quarks, atoms, rocks, trees, planets, and stars of experience and observation. Rather that reality exists in the mathematical perfection of the equations of physics and in the theological perfection of an entity that exists, along with those equations, in a realm beyond human observation. This God is knowable, not by his appearance before us but by his presence as that perfect reality. We all exist in the "mind of God."

A Platonic God is implied in many of these recent dialogues between science and religion. Whether called "God" or "fundamental rationality," the latest statements made by believing scientists seem to rest on a "feeling" that ultimate reality resides in some domain other than the physical one of space, time, mass, and energy.

In the past, arguments over the argument from design have been confined to philosophers and theologians. That was just talk that most scientists ignored. Now we have a few scientists getting involved, and these scientists are going beyond talk, claiming they see *direct evidence* for purposeful design in the universe. As Paul Davies has put it: "The very fact that the universe *is* creative, and that the laws have permitted complex structures to emerge and develop to the point of consciousness—in other

words, that the universe has organized its own self-awareness—is for me powerful evidence that there is 'something going on' behind it all. The impression of design is overwhelming." [22]

This Platonic God need not have anything to do with the God of the Bible or any other imagined deity, abstract or personal. From their writings, I judge that Hawking, Penrose, Weinberg, and other prominent theoretical physicists and mathematicians are Platonists who see a nontheistic reality in the equations of mathematics and physics. They view quantum fields and spacetime metric tensors are "more real" than quarks and electrons.

By contrast, I am a mundane experimental physicist who happens to think that quarks and electrons are more real than metric tensors and fields of any kind. While I cannot prove this, a picture of particulate atoms moving around in an otherwise empty void, as suggested by the highly successful *standard model* of elementary particles and forces, continues to offer the simplest picture consistent with all the data. This model, tied in with the rest of physics, offers a plausible scenario for a designerless universe in which the universal "laws" of physics, such as energy and momentum conservation, are simple statements about the natural symmetries of space and time with other "laws" resulting from the spontaneous, local breakdown of those symmetries. Neither suggest any intelligent design. On the contrary, they strongly imply the opposite.[23]

We will continue to argue about this, although, to be truthful, most physicists and astronomers don't give a hoot, viewing such philosophizing as a waste of time. Even so, most of those who do give a hoot, from both camps, do not view either Platonic or atomic realities as requiring supernatural deities.

Was There a Beginning?

Finally, let me discuss the argument that the universe had a beginning and so must have been created. While big bang cosmology might not be quite as solidly established as biological evolution, it is not far from being so in the view of most cosmologists. Many theists, notably Pope Pius XII, have taken the big bang as confirming Church teachings.[24] However, quite a heavy massaging of scripture is required to make it conform to scientific knowledge.[25] Like life on earth, the universe is also evolving with

time. The light from galaxies far, far away left there long, long ago and those galaxies look markedly different from those near-by. This is very difficult to reconcile with the earth-centered firmament spoken of in Genesis and other parts of the Bible, such as Psalm 103: "The Lord God laid the foundation of the earth, that it not be moved forever." So we should not be surprised to hear objections to the big bang raised by biblical literalists.

For many years, an alternative to the big bang, the steady-state universe of Hermann Bondi and Thomas Gold, remained viable.[26] However, this particular model and others like it are now safely ruled out by the data. Respectable but aging big-bang skeptics, such as Sir Fred Hoyle and retired *Nature* editor John Maddox, are rapidly diminishing in numbers. The big bang is also occasionally called into question in the popular literature, such as in the 1991 book *The Big Bang Never Happened* by science writer Eric Lerner.[27] Lerner's critique of the big bang is easily countered.[28] I know of no active contemporary cosmologist who takes his alternative plasma universe seriously.

The new creationists have exploited this fringe of dissent in cosmology, making it seem more representative than is the case and suggesting that objections to the big bang are theological rather than scientific. Indeed, a reading of Lerner does suggest this interpretation. Theistic physicist Ross asserts that general relativity and the big bang "prove a formidable threat to rational atheism."[29] Not for any rational atheists I know.

Let me assure you that cosmologists are not involved in any Vatican-led conspiracy to promote a creation cosmology. Like eighty percent of physicists and astronomers, most are nonbelievers who see no need for a creator in the data. Most accept the big bang as well-established. In any case, the truth is not determined by democratic vote and most cosmologists are completely committed to letting the observations decide. They know full well that they would be disgraced, their careers ruined, if they were to allow religion or politics to influence their scientific judgments.

Right now, observations strongly support the big bang. But whether they support the notion of a creator is another matter. Ross gives the following "proof of creation":

> The universe and everything in it is confined to a single, finite dimension of time. Time in that dimension proceeds only and always forward. The flow of time can never be reversed. Nor can it be stopped. Because it has a beginning and can move in only one direction, time is really just half a dimension. The proof of creation lies in the mathematical observation that any entity confined to such a half dimension of time must have a starting point of origination. That is, that entity must be created. This necessity for creation applies to the whole universe and ultimately everything in it.[30]

This assertion is based on the ancient, islamic *kaläm cosmological argument*. Christian philosopher William Lane Craig has ecumenically promoted kaläm in his writings and during his frequent public debates on the existence of God. Many other theists, like Ross, have followed his lead. Craig states the argument as a simple syllogism:[31]

(1) Whatever begins has a cause.
(2) The universe began to exist.
(3) Therefore, the universe has a cause.

Craig, Ross and others interpret that cause as the creation.

Note that Craig is not saying that everything in existence must have a cause, which is a common misinterpretation. Only something with a *beginning* is asserted to require a cause. This supposedly defuses the usual atheological query, “What caused God.” Having no beginning, God has no need of a cause, in the theological view.

However, Craig gives no good reason for (1) other than a kind of "metaphysical intuition." He presents his justification this way: ". . . the first premiss is so intuitively obvious, especially when applied to the universe, that probably no one in his right mind *really* believes it to be false."[32] His debate opponent might very well reply: ". . . the first premiss is so intuitively obviously wrong, especially when applied to the universe, that probably no one in his right mind *really* believes it to be true. Then it becomes a food fight over who is in his right mind, the theist or the atheist.

The first kaläm premise (or premiss) has been disputed on the basis of the noncausal nature of quantum phenomena. This and other refutations can be found, along with Craig's updated claims and responses, in the book he co-authored with philosopher Quentin Smith.[33] Let me just mention one argument from physics.

Quantum electrodynamics (QED) is a 50-year-old theory of the interactions of electrons and photons that has made successful predictions, confirmed by experiment, to accuracies as great as twelve significant figures. Fundamental to that theory is the spontaneous appearance of electron-positron (anti-electron) pairs for brief periods of time in the vacuum. Thus we have a counter example to statement (1), something that begins without cause—indeed, something from nothing.

Even if quantum processes are random, the creationist might still argue that they remain causal in nature. “Where did the laws of chance come from?” they might ask, imagining, although Einstein opposed the notion, God playing dice.

Like many of these arguments, it all depends on who is forced to carry the burden of proof. Theist debaters like Craig work very hard on stage to pass the burden off to their opponents, who are usually less skilled at the game and often fall for the ploy. However, Craig and his colleagues must assume the burden. Their theism is the less parsimonious hypothesis, requiring something more than the purely natural. When the burden is squarely placed on their shoulders, where it belongs, the fact that we have, with conventional quantum mechanics, an example of a noncausal mechanism, is sufficient to refute kaläm premise (1).

For Craig, the empirical evidence for the big bang justifies premise (2). He also makes an elaborate philosophical and mathematical argument, in essence concluding that an infinite regress into the past cannot occur and so time must necessarily have a beginning. Here, he seems to assume a Platonic reality to time. If we use the realist physicist’s operational definition of time, as the number of ticks on a clock, then we can have a denumerable infinity of time in the past as well as the future.

Previous responses to Craig, by Smith and others, have not disagreed with premise (2) per se, but questioned whether it even made any sense to talk about a cause before the existence of time. The common assumption among theist and atheist philosophers alike, following St. Augustine, is that time started at the beginning of the

universe. This is usually the position taken by the atheists who debate Craig and other theists.

While I do not dispute this possibility, I have proposed an alternative response in which the assumption of a beginning to time (though not the big bang) is challenged.[34] I will attempt to show that the universe did not necessarily have a beginning, that t = 0 is an arbitrary point, and time exists, at least in an operational sense, on both the negative and positive sides of the time axis.

Recall that the kaläm argument holds that the universe must have been caused since it had a beginning. God, on the other hand, had no beginning and so required no cause. I take this to mean that if I can demonstrate that the universe had no beginning, then Ross, Craig, and other theists who use the kaläm argument will be hoisted on their own petard and forced to admit that the universe required no cause and so was not necessarily created. (Of course they won't).

For this purpose, it should be adequate for me to provide a plausible scenario in which the universe occupies both halves of the time axis around t = 0. Again, because I do not accept the burden of proof in this debate, I do not feel compelled to prove that this scenario is true—just show how it remains viable within the framework of existing knowledge.

My scenario is provided by the inflationary model that currently supplements big bang cosmology. The new creationists and I agree that the big bang is strongly supported by astronomical observations. Inflation remains less firmly established, but remains the only current theory that successfully explains a wide range of observations. Furthermore, the model of inflation is falsifiable, and so maintains good scientific credentials. Indeed, with the 1992 COBE observation of a 1/100,000 fluctuation in the temperature of the cosmic microwave background, inflation passed at least one risky falsification test. Very accurate measurements of the structure of the microwave background will be made in the next few years that should either confirm the predictions of inflation or rule the model out. Let me proceed on the assumption that inflation will survive these tests.

Suppose the universe were at some point in time completely empty of matter, radiation, or energy of any type. At that time it was about as nothing as nothing can

be—a void. Physicists can still describe a void in terms of general relativity. It is completely flat geometrically, with space and time axes that run from minus infinity to plus infinity. Anything else and matter, radiation, or spacetime curvature would have to exist and this universe would no longer be a void. For example, a curved spacetime still empty of matter and radiation has a nonzero energy density.

In the absence of matter and radiation, Einstein's equations of general relativity yield the *de Sitter solution*, which simply expresses the curvature of space as proportional to the *cosmological constant*. When the empty universe is geometrically flat, this term is zero and the equation then reads: 0 = 0. This denotes the void.

We can apply quantum mechanics as well to an empty void. There the uncertainty principle allows for the spontaneous, uncaused appearance energy without violating energy conservation. If that energy appears in a familiar form, matter or radiation, with positive pressure, then it will have to disappear in a short time interval to maintain energy conservation. This can be expected to happen randomly throughout the spacetime void, with no significant permanent result.

However, another possibility exists that can lead to a quite significant and permanent result. The fluctuation energy can appear instead in a form, allowed by Einstein's equations, that has negative pressure. (Negative pressures occur in physics, as for example in a Van der Waals gas under certain conditions). The possibilities include a cosmological constant, corresponding to a spacetime curvature, or some other stuff that now goes by the label of *quintessence.* This ingredient appears within what is called a "bubble of false vacuum." This bubble still contains no familiar matter or radiation, but is no longer a "true vacuum" because of it nonzero energy density. We can only speculate about the nature of quintessence at this time, but in the case of a cosmological constant, the bubble expands exponentially in what is called *inflation*. Quintessence will also lead to inflation, but it may not be exactly exponential.

As the volume of the bubble increases during inflation, the energy contained within also increases exponentially. The first law of thermodynamics is not violated, as the negative pressure does work on the bubble as it expands and its internal energy increases. By the time it has inflated to the size of a proton, in about 10^{-42} second, the bubble contains sufficient internal energy to produce all the matter in the visible

universe today. Frictional processes bring inflation to a halt, particle production begins, and the familiar Hubble expansion of the big bang takes over.

Now, when did this all happen? Any random time. No special point in time exists in the equations of physics. We call the start of inflation t = 0, of course, but this is just by definition. Any point can be arbitrarily labelled t = 0. In fact, the most important law of physics of them all, conservation of energy, demands that there be no distinguishably special moment in time. (In technical terms, energy is the generator of time translation symmetry; when a particular symmetry is obeyed, its generator is conserved). This is why it so important to theologians that there be a unique t = 0. The existence of such a special point would imply the violation of energy conservation, thus leaving room for God to perform that miracle. Ironically, the steady state universe has all the miracles they need—constant violation of energy conservation to account for the expansion of the universe.

In modern cosmology, then, t = 0 is a random point on the time axis that defines the beginning of the inflationary epoch. At that instant, space is empty except for the zero point energy required by quantum mechanics, in this case stored in the curvature of space or in quintessence. In the de Sitter solution of Einstein's equations for curved, empty space, exponential inflation occurs on the positive side of the t-axis. But what defines the positive side? As first suggested by Boltzmann a century ago, the direction of time is by definition the direction in which the entropy of the universe, the bubble in this case, increases. That is, the positive side of the t-axis is the side in which entropy grows as you move away from t = 0.

Now, what about the negative side of the t-axis, the other half dimension? If we look at Einstein's equations, nothing forbids an expansion in that direction as well. Physicists usually simply ignore that solution because most share Ross's prejudice, expressed above, that time "proceeds only and always forward." But the equations of classical or quantum physics, including those of general relativity, make no fundamental distinction between the two time directions. Where that distinction appears, it is put in by hand as a boundary condition.

However, a completely time-symmetric solution of Einstein's equations for the vacuum will give exponential inflation on both sides of the time axis, proceeding away

from t = 0 where the initial quantum fluctuation was located (see figure 2). This implies the existence of another part of our universe, separated from our present part along the time axis. From our point of view, that part is in our deep past, exponentially *deflating* to the void prior to the quantum fluctuation that then grew to our current universe. However, from the point of view of observers in the universe at that time, their future is into our past—the direction of increasing entropy on that side of the axis. They would experience a universe expanding into their future, just as we experience one expanding into our future. In other words, each side of the time axis has an arrow pointing away from the origin.

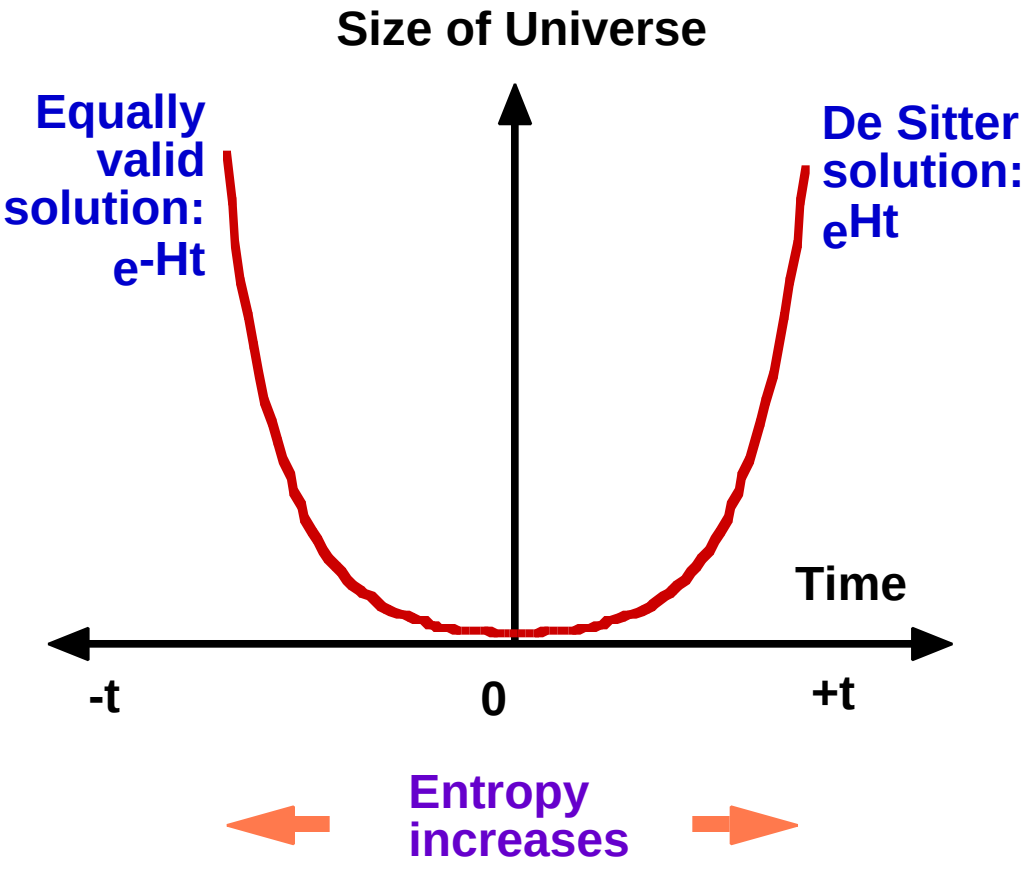

Figure 2 . The time-symmetric inflationary universe. Starting at t = 0, the universe undergoes a short period of exponential expansion on both the +t and -t side of the time axis, where time's arrow runs away from zero on both sides.

Would these different parts of the universe be identical, kind of mirror images of each other? Not unless physics is completely deterministic, which we do not believe to be the case. The two parts would more likely be two very different worlds, each expanding in its own merry way, filled with all the other random events that lead to the evolution of galaxies, stars, and perhaps some totally different kind of life.

This scenario also serves to explain why we experience such a large asymmetry in time while our basic equations exhibit perfect symmetry.[35] Fundamentally, the universe as a whole is time-symmetric, running all the way from minus eternity to plus eternity with no preferred direction, no "arrow" of time. Indeed, the whole notion of beginning is meaningless in a time-symmetric universe. And, without a beginning, the kaläm cosmological argument for a creator fails because of the failure of step (2) in Craig's syllogism.

I have described a scenario for an infinite, eternal, and symmetric universe that had no beginning (and, symmetrically, no end). The quantum fluctuation occurs at random spatial and temporal point in an infinite void. Obviously it could have happened more than once in this void and probably did. This multiple universe scenario is exactly what is suggested by the chaotic inflationary model of Andre Linde.[36] While multiple universes are not required to deflate the kaläm argument, they can be used to provide a scenario by which the so-called anthropic coincidences may have arisen naturally. Again, this scenario cannot be proven, and I know that theists will criticize it as "speculative." But their God is even more speculative; at least my speculations are based on established science. I have presented a more parsimonious, non-supernatural alternative to theistic creation that cannot be ruled out within existing knowledge.

Summary

Intelligent Design is the new buzz word for what used to be called “creation science.” It claims scientific evidence for purpose in nature based as follows:

- Information theory proves that the complexity of life and the universe as a whole cannot be generated by natural processes.
- The laws and constants of physics are fine tuned for life and impossible by

chance.

- Big bang cosmology implies a miraculous creation of the universe.

However, the information theory argument is little more than the old creationist misinterpretation of the second law of thermodynamics. Sequences of complex, specified information can be generated naturally and happen every day. Dembski's "law of conservation of information" disagrees with the second law of thermodynamics.

No known laws of physics were violated, no "miracle" occurred, at the beginning of the big bang. The laws of physics can be understood in terms of natural global symmetries and accidental local broken symmetries. We cannot rule out a high probability of some kind of life in a random universe. Multiple universes also cannot be ruled out. The universe seen by physics and astronomy is fundamentally time symmetric implying no beginning, no preferred direction of time, and no creation.

Theological Implications

Despite all the hype, science has found no scientific evidence for God. However, this does not “disprove” the existence of God. A logically consistent theology that includes science is always possible. A logically consistent science that includes theology (i.e., supernatural processes) is also possible, but is non-parsimonious and so must be required by the data before being considered.

The new creationists seek to undermine science because of what they see as an underlying, dogmatic assumption of purposelessness. Once again they demonstrate how little about science they know. Science is not dogmatic about purpose, or anything else. It will go wherever the data lead.

The author maintains an Internet discussion list <avoid-l@hawaii.edu> which provided many useful comments on the subject of this paper.

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