Physics, Cosmology and the New Creationism

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The New Design Arguments

While the argument from design is an ancient one, new variations have appeared in recent years. There are three main forms of the design argument today. In one form, referred to as “intelligent design,” the modern science of information theory is brought to bear to supposedly "prove" that certain biological systems cannot have arisen naturally (see Elsberry, Pennock this volume). In a second form, the cosmological evidence that our universe begin with the Big Bang 13–15 billion years ago is claimed to demonstrate that the universe was divinely created. In a third form, the laws and constants of physics are said to be so finely tuned for life that they could only have arisen by the act of a creator with the purpose of producing humanity. Each of these contributes to the rather vague concept known as “intelligent design” theory. But each of them has serious flaws and neither stand up on their own nor present any significant challenge to modern naturalistic science.

Information Theory and Intelligent Design

In his extensive writings*,* William Dembski claims to use information theory to demonstrate that biological systems are too complex to have been formed by purely natural processes and so must have been "intelligently designed" (Dembski 2002, 1999, 1998). However, he has not applied information theory as it is conventionally practiced in that field (see Elsberry and Pennock for further discussion). Despite pages of formulae and complex descriptions, Dembski makes at least one elementary mistake that casts doubt on the whole enterprise. He incorrectly derives *his* definition of “the measure of information in an event” from natural sources.

Dembski defines the "measure of information in an event of probability p as $-\log_2 p$". He cites as a reference *The Mathematical Theory of Communication* by Claude Shannon and Warren Weaver (1949). Shannon is regarded as the father of information theory, and his work is the foundation for the research in this field for nearly 60 years. In his work at Bell Labs, Shannon was concerned with the efficient communication of electronic signals: how certain we could be that specific symbols were received. Let us give a summary of his theory, which is now widely applied in communications engineering.

Suppose we want to transmit a message containing a single symbol, such as a letter or number, from a set of *n* symbols. Shannon defined a quantity:

$$H = -\sum_i p_i \log_2 p_i = -\langle \log_2 p_i \rangle \qquad (1)$$

which he called "the entropy of the set of probabilities $p_1 \ldots p_n$" for the symbols in the message. That is, p_i is the probability of the presence of *ith* symbol in the list. Because of the base-2 logarithm, the units of H are *bit*s — or in binary format. The angle brackets in (1) refer to the average of the enclosed quantity, and the fact that H is an average over an ensemble of symbols is important to keep in mind in the ensuing discussion. In today's literature on information theory, H is called the *Shannon uncertainty.*

The information R carried by a message is defined as the decrease in Shannon uncertainty when the message is transmitted. That is,

$$R = H(\text{before}) - H(\text{after}) \quad (2)$$

If we consider the special case when all the probabilities p_i are equal to p, we get the simpler form:

$$H = -log_2 p \quad (3)$$

Let us illustrate the idea of information with a simple example of a single-character message that can be one of the eight letters S, T, U, V, W ,X, Y, or Z with equal probability. Before the message is transmitted, the number of symbols $n = 8$, the probability of a given symbols is then $p = 1/8$, and the Shannon uncertanty $H(\text{before}) = -log_2(1/8) = log_2(8) = 3$. After the message is successfully transmitted we know what the character is, so $p = 1$ and $H(\text{after}) = -log_2(1) = 0$. Thus $R = 3$ bits of information are received as the uncertainty is reduced by 3 bits.

Now suppose that the message is a little garbled so that we know the symbol transmitted is either a U or a V, but we cannot tell which and they have equal probability. Then, after the message is received, the probability reduces to $p = 1/2$ and $H(\text{after}) = -log_2 (1/2) = 1$. In that case, $R = 3 - 1 = 2$ bits of information are received. Here, uncertainty is reduced, as well, but because the *reduction* in uncertainty is less, the second transmission has less information.

Dembski's definition of information, $I_D = -log_2 p$, is identical to the Shannon uncertainty in the *special case* of equal probabilities given by equation (3). In our example, the probability of each character is $p = 1/8$, so $I_D = -log_2(1/8) = 3$ bits, as above. However, because Dembski's rendering of this definition is not conventional, it will equal R, as given in equation (2), *only* for equal probabilities and *only* when the transmission is *perfect* so that $H(\text{after}) = 0$. While Dembski refers to Shannon, he does not mathematically derive the expression for information he uses from Shannon's expression — nor does he justify it by any other method. His examples, however, indicate that he does no*t* limit himself to cases having equal probabilities within an ensemble of symbols or "events". Neither does he average the probabilities over the ensemble. In fact, his so-called "information" is really just another way of writing the probability p of an event in logarithmic form. This quantity is called *surprisal* in the literature.[1]

Before continuing with Dembski's peculiar version of "information," let us take a closer look at the interpretation of the Shannon uncertainty H. Shannon notes that "The form of H will be recognized as that of entropy as defined in certain formulations of statistical mechanics," referring to the classic monograph *The Principles of Statistical Mechanics* by Richard Tolman (1938). Shannon explicitly states that "H is then, for example, the H in Boltzmann's H-theorem."

Actually, in statistical mechanics the quantity we will call H_{SM} is defined without the minus sign and using the natural logarithm:

$$H_{SM} = \sum_i p_i \, log_e \, p_i \quad (4)$$

However, Shannon notes that any constant multiplying factor, positive or negative, could have been used because constants do not affect the underlying relationships among variables. The main reason for the choice of multipliers is to set the units for the outcome of the calculation. The choice Shannon made in Equation (1) produces a result measured in bits.

[1] I am grateful to Richard Wein for clarifying for me what Dembski has done.

Boltzmann and Josiah Willard Gibbs found that the laws of classical continuum thermodynamics could be derived from statistical mechanics on the assumption that matter was composed of atoms (whose existence had not yet been fully confirmed by experiment at that time). In particular, the quantity H_{SM} was seen to be simply related to the thermodynamic entropy S by the relationship in this equation: $S = -kH_{SM}$, where k is Boltzmann's constant. The H-theorem implied that the entropy approaches maximum at equilibrium, and this gave a statistical explanation for the Second Law of Thermodynamics, which says that the entropy of an isolated system will increase with time or stay constant. The relationship between the entropy S of statistical mechanics and Shannon's uncertainty H is

$$S = k \log_e(2)H \qquad (7)$$

Comparing the relationships in Equations (1) and (4) shows that S and H are equal within a constant and have the same sign. So, Shannon was justified in calling H the "entropy."

Summarizing the conclusions of this section: (1) Dembski's definition of information is not that used in the discipline of information theory, (2) information is conventionally defined as the change of a quantity called the Shannon uncertainty, and (3) entropy and Shannon uncertainty are comparable constructs and equal within a constant.

Conservation of Information

Dembski claims to prove a principle he calls, borrowing the term from the1960 Nobel laureate in Medicine, Peter Medawar, the *Law of Conservation of Information.* According to Dembski's—but not Medawar's—version of this principle, the number of bits of information cannot change in any natural process such as chance or the operation of some physical law. As Dembski states it, "chance and law working in tandem cannot generate information" (Dembski 1999: 168). I show that this is incorrect, when interpreted as some universal principle applying under all circumstances.

Now, in most of Dembski's writings he focuses on a quantity he calls *complex specified information (CSI*), which I will discuss below. It would be reasonable to infer that Dembski intends his law of conservation of information to apply only to this type of information. However, he is quite inconsistent on this and his "derivation" of conservation of information recognizes no such restriction. His “law” is meant to imply universal constraints on changes in information applicable to biological complexity.

The basic idea of conservation of information, as used by Dembski, is simple and illustrated in Figure 1. Suppose we start out with a certain number of bits of information (that is, Shannon uncertainty) about a system. For example, system might be composed of five coins. Any configuration of heads or tails is information that can be represented by five bits. For example, HTTHT = 10010. According to Dembski, two possible natural processes can act on that information. One is some well-defined operation that can be likened to the action of a physical law or computer algorithm. For example, the operation might be: every time a flipped coin lands on the table, turn it over. Thus we have HTTHT ® THHTH, or 10010 ® 01101. Clearly, the number of bits has not changed and so, while the message may be different in *content*, it contains no more or less *information* than previously. In this process at least, information is conserved. In his book *The Limits of Scienc*e, Medawar (1984) described the impossibility of creating new information from closed logical systems: "No process of logical reasoning—no mere act of mind or computer-programmable operation—can enlarge the information content of the axioms and premises or observation statements from which it proceeds." However, unlike Dembski, Medawar did not claim this was a *universal* principle but only that it applied to *closed* systems, a limitation that Dembski does not admit. Medawar also made no claim that the same rule applied to chance processes, which Dembski includes in his version of the principle.

Let us look at what happens to our original information representing five coin tosses under the operation of random chance. Regardless of the original bit sequence, the process will produce a new one in which H and T are equally likely at any location in the sequence. Thus HTTHT ® TTHTT or HHTTH (10010 ® 00100 or 11001) or any other possible permutation. Again, the number of bits does not change and so no *information* is generated or lost. Thus, Dembski claims, the very existence of information in the universe is irrefutable evidence for the existence of design. This conclusion has left many people impressed. For example, Rob Koons, an associate professor of philosophy at the University of Texas, calls Dembski the "Isaac Newton of information theory" (Kern 2000) Hardly.

First, as we have already noted, Dembski's definition of information does not correspond to that used in the field, except as a special case to which he does not limit himself. We have seen that information is conventionally defined *in this field* as the decrease in Shannon uncertainty during the transmission of a message. Furthermore, we have seen that Shannon uncertainty is equal, within a constant, to the entropy used in statistical mechanics. It has been well known in physics for more than a century that *entropy* is *not* conserved. In fact, the *Second Law of Thermodynamics* says that the total entropy of an isolated system of many bodies must remain constant *or increase,* as implied by Boltzmann's *H*-theorem discussed above.

On the other hand, entropy can *decrease* for non-isolated systems, which happens when they are organized from the outside, or in any system with small numbers of particles. It is important to realize, in fact, in the example I gave above of the transmission of a message, the entropy/uncertainty *does* decrease (and information *increases*). This is an illustration of a non-isolated system, the transmitter, sending information to another non-isolated system, the receiver. The result is not the *conservation* of information, but an increase in information as the Shannon uncertainty decreases.

Indeed, every time we rub our hands together we are making entropy. From an information standpoint, the Shannon uncertainty is increasing (the molecular motions in our hands are becoming more irregular) and so information is being lost. It is possible to come up with many examples in which information is not conserved. Thus, Dembski's "proof" fails because it violates the Second Law of Thermodynamics. Actually, Dembski is aware that information can degrade (Dembski 1999: 70), but this only demonstrates his inconsistency. His "law" of conservation of information does not permit this.

Now, perhaps Dembski might argue that it was not his intent to define information in terms of the Shannon uncertainty, although he uses Shannon as a reference and mentions no other source. In any case, we can show that we can still imagine natural processes adding bits of Dembski information to a system. A computer simulation can be used to illustrate this, but ID proponents can (and often do) object that such a simulation is still "designed". Let us consider instead an example that involves only chance, with no designer intervention.

Suppose we have two bar magnets, one sitting on top of the other, as shown in figure 2(a). Because of their mutual attraction, only the two configurations shown, with either both north poles up or both south poles up, will be stable. This can be specified by one bit of Dembski information, say $I_D = 1$ for north poles up and $I_D = 0$ for both north poles down. We open the window and a random breeze comes through and knocks the magnets apart. Assume they are constrained so they cannot fall on their sides but must always land vertically.

Now, because the poles are no longer in contact, the four configurations shown in (b) are possible We then need two bits to describe the situation: $I_D = 11$ for both north poles up, $I_D = 10$ for the first north up and the second down, $I_D = 01$ for the second north up and the first down, and $I_D = 00$ for both north poles down. The calculation of H according to Equation (3) reflects the change from 1 bit to 2 bits of information in this system. Thus, the information in the system has increased by one bit as the result of a chance process. (We would need even more bits to describe the possible orientations for the magnets on their sides.) In this example, then, Dembski information is generated by chance, in violation of Dembski's law of conservation of information. This simple example shows how Dembski's concept of this "law" is not found in the standard usages and practices within the field of information theory: because it is patently incorrect.

Panning for Design

The law of conservation of information is not the only unloaded weapon to be found in the arsenal of "intelligent design". Dembski attempts to show that design is evident by virtue of what, in his personal estimation, are probabilities that are too low for the natural production of order. Indeed, when one looks at all the variations in the argument from design that have appeared over the years, including the most recent, they amount to nothing more than the claim that "I cannot see how the universe and life could have happened naturally, therefore they must have been created supernaturally" (See Elsberry and Pennock, this volume). This conclusion appears to be simply due to a failure of imagination.

Dembski introduces a series of "filter*s"* which he applies to observed phenomena in order to determine whether or not they are designed (See Elsberry, this volume). He tests these filters by applying them to examples of *human* design, on the assumption that any "intelligent agent" must follow the same rules. Starting with information, his filters accept only information that is both *complex* and *specifie*d. The resulting complex–specified information (CSI) is then interpreted as the consequence of "intelligent design". Let us consider these criteria in terms of the example of five consecutive coin tosses discussed above. We saw that this system has five bits of Dembski information. Suppose that, before the first toss, we *specify* a particular sequence, say all heads, HHHHH. Or, it could be all tails or any other sequence, such as HTTHT, as long as it is specified in advance.

Now, five heads in a row, or any other sequence of five coins, will happen frequently by chance. On average, about one in every $2^5 = 32$ 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 in advance that all fall heads up. It would require $2^{500} = 10^{150}$ tosses of 500 coins each, again on average, to obtain 500 heads specified in advance in an event of 500 consecutive coin tosses by chance. That is, the probability for this outcome is 10^{-150}, and the Dembski information contained in the event is 500 bits. Dembski says this is impossible, for all practical purposes, to produce this *particular* pre-specified array, and he uses any event containing of at least 500 bits of information as his working definition of "complex" (Dembski 1999: 70). This, he notes, is a far more stringent restriction than the 166 bits implied by the "universal probability bound" of $10^{-50} = 2^{-166}$ proposed by mathematician Emile Borel (1962: 28).

However, while some *pre-specified* sequence of 500 bits, such as all heads or any other specific pattern of heads and tails selected before the fact, has this very low probability of being produced by chance, the probability for *some* pattern of heads and tails in 500 tossed coins (or any number of tosses) is 100 per cent! That is, one of the 10^{-150} possible combinations *must* occur each time, even though the prior probability of producing each one o them is very, very small. So, if after the coins are tossed we look at the sequence that is produced we cannot very well say that particular sequence is impossible when there it is, staring us in the face.

Physicist, and theist, Howard Van Till points out that Dembski's definition of complexity is highly unorthodox in light of how it is applied. For example, Dembski argues that any biotic system is complex if the probability for its being assembled by natural processes is less than 10^{-150} . This subtly changes the meaning of “complexity” from a property of the system (which Dembski claims to be calculating) to an inference about the means by which that system is actualized (which is closer to what he is really calculating) (Van Till 2002). Furthermore, when Dembski actually calculates the probability for a specific system, such as the flagellum in *E. coli* bacteria, he does so by assuming that the system was assembled by chance processes *alone* (Dembski 1999: 178). Van Till comments: "We reject that argument as a totally unrealistic caricature of how the flagellum is actualized and an approach that totally ignores the role of the bacterial genome in coding for all of the structures and functions that contribute to the nature of *E. coli*" (Dembski 1999: 178). While the chance probability might be less than the probability bound, the probability for chance plus other natural processes, such as natural selection, will always be greater.

Unfortunately, Dembski does not define specificity as precisely as he does complexity (even though his definition of this concept is idiosyncratic). In the coin example I have used, Dembski’s approach requires that the sequence is specified in advance. This is fine, except in nature, we do not possess knowledge of the pre-specified sequence. If Dembski left his models at this point, it would defeat his whole program to detect design *after the fact*. So, as a dubious and dangerous tactic, he allows specificity to be *post*-determined. This approach is presumed to capture "design information" that would otherwise be written off to chance—perhaps rightly so (See Elsberry, this volume). However, in the coin example above, this would be equivalent to waiting until the toss was over and then saying, “Yes, that was the complex pattern that I specified.” Although specificity is difficult to define, like pornography, we are supposed to know it when we see it. Once again, despite claims of mathematical rigor, it all comes down to a subjective judgment that the structure of a given biological system contains complex specified information — after the fact — that can be demonstrated *not* to result from chance or natural processes.

At the Beginning

The new creationism couched in the rhetoric of “intelligent design” theory implies more than just a continuation of the same old attacks on biological evolution. For example, biochemist Michael Behe’s concept of irreducible complexity can be extended well beyond the realm of biology to the behavior of any nonlinear system (Behe 1996). “Intelligent design” can be proposed for the formation of galaxies as well as of bacterial flagella. The “intelligent design” creationists claim to see positive evidence for a creator in the data from physics and astronomy, as well as biology (Ross 1995).

ID theorists capitalize on the common belief that one or more miracles were required to produce the universe. One such presumed miracle is the violation of *energy conservation* or what is equivalent, the *First Law of Thermodynamic*s. Anti-evolutionists ask: "Where did the energy and matter of the universe come from?" In fact, astronomical observations strongly indicate that the mean energy density of the universe is exactly what would be expected if there were zero initial energy at the start of the Big Bang and would require no violation of the laws of energy conservation (Ostriker and Steinhardt 2001).

Another miracle widely believed to have occurred at the beginning of the universe is the violation of the *Second Law of Thermodynamic*s. On the assumption that no forces act on it from the outside, the universe is an *isolated* system. Thus, it would appear that no gain of information (loss of entropy) with time is possible in the universe as a whole, since the Second Law is interpreted to mean that isolated systems tend to become more *dis*organized over time. However, recent research has show that even if the universe began in complete disorder local pockets of order can still form as time progresses without violating the Second Law. This is made possible by the expansion of the universe, which continually opens up more room for order to form (Stenger 1990, 1988).

Several cosmological scenarios have been published by established scholars in reputable scientific journals that allow for a universe to appear as an uncaused quantum event from an initial state of zero energy (Linde 1984; Atkatz and Pagels 1982; Hawking and Moss; 1982 Vilenkin 1982). Edward Tryon may have been the first to publish this idea (Tryon 1973). The published models illustrate that serious attention is being given to the possibility of an uncaused origin of the universe. Although they may turn out to be incorrect in many specifics, the proposed scenarios for a purely natural origin of the universe are consistent with existing knowledge in physics and cosmology. This serves to refute any claim that the origin of the universe currently *requires* a miraculous creation because science has no mechanism or process that could account for this event.

It is conventional to label the time of the Big Bang as t=0. However, nothing we know demands that this was the beginning of time, as is often assumed by theologians (Craig 1979), or that no universe existed at earlier times. Nonspecialists often read that we cannot understand what happens very near $t = 0$ because to do so requires a theory of quantum gravity — a marriage between quantum mechanics and general relativity that does not yet exist. This is true for the origin of the universe; but it is equally true for any other point in time — such as the instant the reader's eye reaches the period at the end of this sentence.

Every point on the time axis, including "now", is surrounded by a small time interval within which our current theory of gravitation, Einstein's general theory of relativity, does not apply. General relativity is not a quantum theory, and quantum gravitational effects are important when time intervals are as small as 10^{-43} second (what is called the *Planck time*). Similarly, every point in space is surrounded by a tiny sphere of radius 10^{-35} meter — a distance called the *Planck length* — where general relativity also does not apply.

The Heisenberg uncertainty principle of quantum mechanics makes it impossible to measure any time interval smaller than the Planck time or distance smaller than the Planck length.

According to physics convention, time and distance are *operationally defined* by their measurements. Thus, unless one changes that convention, it is physically meaningless to talk about distance and time as having any quantitative values within a sphere of Planck dimensions — even with a theory of quantum gravity. Furthermore, the inability to define distance and time within these dimensions implies that no other physical quantity, at least in current physics, can be measured since they are all defined in terms of space and time. And, if no measurements are possible, neither is information. Thus we have a condition of complete uncertainty or maximum entropy.

And so, this was the state of the universe in a 10^{-43} second time interval around t = 0, if it was confined within a Planck sphere as Big Bang cosmology implies. The universe was then in a condition of maximum entropy and zero information — total chaos. If a supernatural creation occurred at this point, it was a creation *without design*, since the universe was without order. As already indicated, no violation of the Second Law of Thermodynamics is implied by a universe that begins with maximum entropy since the expanding universe that follows allows increasing room for order to form.

Is the Universe Fine Tuned for Humanity?

The latest claim of evidence for divine cosmic plan with humans in mind is based on the fact that earthly life is so sensitive to the values of the fundamental physical constants and properties of its environment that even the tiniest changes in any of these would mean that life, as we see it around us, would not exist. This is said to reveal a universe in which physics is exquisitely fine tuned — delicately balanced for the production of life. The delicate connections among certain physical constants, and between those constants and life, are collectively called the **anthropic coincidence**s. For a detailed history and a wide-ranging discussion of all the issues, see *The Anthropic Cosmological Principle* by Barrow and Tipler (1986).

Many theists see the anthropic coincidences as evidence for purposeful design to the universe. They ask: "How can the universe possibly have obtained the unique set of physical constants it has, so exquisitely fine tuned for life as they are, except by purposeful design — design with life and perhaps humanity in mind?" (Ross 1995: 118; Swinburne 1990). Let us examine the implicit assumptions here. Foremost, and fatal to the design argument all by itself, is the wholly unwarranted assumption that only *one type of life is possibl*e — the particular form of carbon-based life we have here on earth. Carbon would seem to be the chemical element best suited to act as the building block for the type of complex molecular systems that develop lifelike qualities. Even today, new materials assembled from carbon atoms exhibit remarkable, unexpected properties, from superconductivity to ferromagnetism. However, to assume that *only* carbon life is possible is simply "carbocentrism" that results from the fact that you and I are constructed mainly of carbon.

Given the known laws of physics and chemistry, we can imagine life based on silicon (computers, the Internet?) or other elements chemically similar to carbon. After all, it is the collection of chemical properties and interactions of carbon that make it such a useful building block for life, so why might other elements with similar properties not also serve this purpose under the proper conditions? Furthermore, nothing in anthropic reasoning indicates any special preference for *human* life, or indeed intelligent or sentient life of any sort — just carbon.

Going further, just because we can generalize about the universe that we live in and how life fits into it, we cannot rule out that forms of matter in the universe other than molecules could serve as building blocks for complex systems. The way that atoms assemble into molecular structures perhaps might be very different in a universe with different properties and laws. Those who argue that life is highly improbable except as a result of an universe uniquely and intelligently designed to produce it need to confront the possibility that life of some type might be likely with many different configurations of laws and constants of physics — without any violation of the expectation that natural processes following these laws are capable of producing living things that conform to the laws on which those universes might by based.

The Multiverse

If our universe appeared as a quantum fluctuation in a pre-existing space-time void, this could have happened more than once — and probably did. The multiple universe scenario is implied by the original suggestion of Tryon and imbedded in the cosmological model of Andre Linde (Linde 1994, 1990, 1984). If the universe as a whole is infinite in extent in both space and time, and we have no scientific reason to think it is not, then sub-universes can be expected to pop up randomly at different positions and times. They appear as expanding bubbles that move away from one another, never colliding or coalescing.

While the multiple universe, or *multiverse*, concept is not required to deflate the fine tuning argument — which we saw above fails on its own accord — this scenario can be used to provide a natural explanation for the so-called anthropic coincidences. The model suggests a simple mechanism by which universes of all types of structures can arise. The kinds of particles present, the forces between them, and various physical constants can be expected to be different from sub-universe to sub-universe. Some of the sub-universes will likely contain little of interest, and some may not contain structures like stars that live very long and manufacture complex elements that can serve as platforms for life. But many others can be expected to contain complex systems capable of evolving into something resembling life (or, indeed, perhaps something resembling nothing with which we are familiar and even far exceeding human life and mind in wondrous capabilities). Thus, our particular sub-universe only appears to be fine tuned for us because it is that sub-universe which happens to contain the properties needed for our *kind* of life to evolve.

Some have argued that the multiverse scenario is less economical than one in which only a single universe exists. However, since multiple universes are suggested by existing knowledge, and no known principle rules them out, it becomes, in fact, less economical to assume a single universe. For example, the atomic theory of matter introduced many more elements than were involved in prior physical theories, but explains matter more parsimoniously and completely than those earlier theories. In a similar way, the multiverse scenario provides a more robust framework for studying cosmology than the models based on a single universe. What is more important for the anthropic coincidence, however, is that current research in physics and cosmology suggest that the “designed for life as we know it” argument may be exactly backward, as any life that appeared in any of the universes that are possible would have to be subject to the laws and constants that govern those universe — not the other way around.

Summary and Conclusions

Modern variations of the ancient argument from design form the basis of the new creationism — so-called “intelligent design” theory. These arguments amount to nothing really new and are just restatements — in ostensibly more sophisticated language of the common-sense view — that the universe and life appear to be too complex to have happened without supernatural intervention. However, the new creationism *poses* as science. Despite their pretense of scientific legitimacy, several of the claims of this new "science" are provably wrong. Demsbki's "Law of Conservation of Information" violates the Second Law of Thermodynamics. Furthermore, his calculation of the probability that the flagellum of *E. coli* bacteria could be assembled by natural processes alone wrongly assumes that *only* chance processes operate.

On the cosmological scale, the new creationism claims that the Big provides evidence that a miraculous origin of the universe is required by current science. This is refuted by the fact that modern cosmology provides several naturalistic scenarios by which the universe began as an uncaused quantum event that violated no laws of physics. No scientific basis exists for assuming that a universe did not exist before the Big Bang. The new creationism also asserts that life would not exist but for an exquisite fine tuning of the constants of physics, the so-called anthropic coincidences. This is true, but only for life as we know it; there is no scientific basis for assuming that other forms of life cannot emerge in a universe with different constants and laws.

Furthermore, the multiple universe scenarios suggested by modern cosmology provide a means by which the so-called anthropic coincidences may have arisen naturally. Earthly species simply emerged in that universe with suitable properties. Our universe is then not fine-tuned for humanity; *humanity* is fine-tuned for our universe.

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