Dear Readers:

Attached you will find the fine-tuning paper that will be read for Friday's colloqium. Only the double-spaced portions will be read orally, but feel free to raise questions about any part of the paper. Also, you should note that this is a technically explanded version of a paper that was originally written for an intelligent lay audiance, and hence to some extent you might find a mixture of two different styles at various points in the paper.

The Fine-Tuning Design Argument: Technical Version

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I. INTRODUCTION

The Evidence of Fine-tuning

Suppose we went on a mission to Mars, and found a domed structure in which everything was set up just right for life to exist. The temperature, for example, was set around 70^{o} F and the humidity was at 50%; moreover, there was an oxygen recycling system, an energy gathering system, and a whole system for the production of food. Put simply, the domed structure appeared to be a fully functioning biosphere. What conclusion would we draw from finding this structure? Would we draw the conclusion that it just happened to form by chance? Certainly not. Instead, we would unanimously conclude that it was designed by some intelligent being. Why would we draw this conclusion? Because an intelligent designer appears to be the only plausible explanation for the existence of the structure. That is, the only alternative explanation we can think of--that the structure was formed by some natural process--seems extremely unlikely. Of course, it is *possible* that, for example, through some volcanic eruption various metals and other compounds could have formed, and then separated out in just the right way to produce the "biosphere," but such a scenario strikes us as extraordinarily unlikely, thus making this alternative explanation unbelievable.

The universe is analogous to such a "biosphere," according to recent findings in physics. Almost everything about the basic structure of the universe--for example, the fundamental laws and parameters of physics and the initial distribution of matter and energy--is balanced on a razor's edge for life to occur. As the eminent Princeton physicist Freeman Dyson notes, "There are many . . . lucky accidents in physics. Without such accidents, water could not exist as liquid, chains of carbon atoms could not form complex organic molecules, and hydrogen atoms could not form breakable bridges between molecules" (p. 251)--in short, life as we know it would be impossible.

Scientists call this extraordinary balancing of the parameters of physics and the initial conditions of the universe the "fine-tuning of the cosmos." It has been extensively discussed by philosophers, theologians, and scientists, especially since the early 1970s, with hundreds of articles and dozens of books written on the topic. Today, it is widely regarded as offering by far the most persuasive current argument for the existence of God. For example, theoretical physicist and popular science writer Paul Davies--whose early writings were not particularly sympathetic to theism--claims that with regard to basic structure of the universe, "the impression of design is overwhelming" (Davies, 1988, p. 203). Similarly, in response to the life-permitting

fine-tuning of the nuclear resonances responsible for the oxygen and carbon synthesis in stars, the famous astrophysicist Sir Fred Hoyle declares that:

> I do not believe that any scientists who examined the evidence would fail to draw the inference that the laws of nuclear physics have been deliberately designed with regard to the consequences they produce inside stars. If this is so, then my apparently random quirks have become part of a deep-laid scheme. If not then we are back again at a monstrous sequence of accidents. [Fred Hoyle, in *Religion and the Scientists*, 1959; quoted in Barrow and Tipler, p. 22]

A few examples of this fine-tuning are listed below:

> 1. If the initial explosion of the big bang had differed in strength by as little as 1 part in 10^{60}, the universe would have either quickly collapsed back on itself, or expanded too rapidly for stars to form. In either case, life would be impossible. [See Davies, 1982, pp. 90-91.] (As Paul Davies points out (1983, p. 179), an accuracy of one part in 10^{60} can be compared to firing a bullet at a one-inch target on the other side of the observable universe, twenty billion light years away, and hitting the target.)
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> 2. Calculations indicate that if the strong nuclear force, the force that binds protons and neutrons together in an atom, had been stronger or weaker by as little as 5%, life would be impossible. (Leslie, 1989, pp. 4, 35; Barrow and Tipler, p. 322.)
>
> 3. Calculations by Brandon Carter indicate that if gravity had been stronger or weaker by 1 part in 10^{40}, then life-sustaining stars like the sun could not exist. This would most likely make life impossible. (Davies, 1984, p. 242.)
>
> 4. If the neutron were not about 1.001 times the mass of the proton, all protons would have decayed into neutrons or all neutrons would have decayed into protons, and thus life would not be possible. (Leslie, 1989, pp. 39-40)
>
> 5. If the electromagnetic force were slightly stronger or weaker, life would be impossible, for a variety of different reasons. (Leslie, 1988, p. 299.)

Imaginatively, one could think of each instance of fine-tuning as a radio dial: unless all the dials are set exactly right, life would be impossible. Or, one could think of the values of the initial conditions of the universe and the fundamental parameters of physics as coordinates on a dart board that fills the whole galaxy, and the conditions necessary for life to exist as a small one-foot wide target: unless the dart hits the target, life would be impossible. The fact that the dials are perfectly set, or the dart has hit the target, strongly suggests that someone set the dials or aimed the dart, for it seems enormously improbable that such a coincidence could have happened by chance.

Although individual calculations of fine-tuning are only approximate and could be in error, the fact that the universe is fine-tuned for life is almost beyond question because of the large number of independent instances of apparent fine-tuning. As philosopher John Leslie has pointed out, "clues heaped upon clues can constitute weighty evidence despite doubts about each element in the pile" (1988, p. 300). What is controversial, however, is the degree to which the fine-tuning provides evidence for the existence of God. As impressive as the argument from fine-tuning seems to be, atheists have raised several significant objections to it. Consequently, those who are aware of these objections, or have thought of them on their own, often will find the argument unconvincing. This is unfortunate, particularly since the fine-tuning argument is probably the most powerful current argument for the existence of God. My goal in this chapter, therefore, is to make the fine-tuning argument as strong as possible. This will involve developing the argument in as objective and rigorous way as we can, and then answering the major atheist objections to it.

Two Preliminary Distinctions

To rigorously develop the fine-tuning argument, we will find it useful to introduce some distinctions and definitions. First, we need to distinguish between what I will call the *atheistic single-universe hypothesis* and the *atheistic many-universes hypothesis*. According to the atheistic single-universe hypothesis, there is only one universe, and it is ultimately an inexplicable, "brute" fact that the universe exists and is fine-tuned. Many atheists, however, advocate another hypothesis, what I call *the atheistic many-universes hypothesis*, which attempts to explain how the seemingly improbable fine-tuning of the universe could be the result of chance. According to this hypothesis, there exists what could be imaginatively thought of as a "universe generator" that produces a very large or infinite number of universes, with each universe having a randomly selected set of initial conditions and values for the parameters of physics. Because this generator produces so many-universes, just by chance it will eventually produce one that is fine-tuned for intelligent life to occur.

Second, we will need carefully to define what we mean by the "fine-tuning." For the purposes of the argument below, we shall mean by the "*fine-tuning*" the claim that the range of those values for the parameters of physics that we have good reason to believe are life permitting is very small compared with the total range of parameters for which we can reasonably determine whether or not they are life permitting. Put imaginatively, one can think of the possible values of the parameters of physics as coordinates on a dart board that stretches to infinity, with a region of the dart board illuminated by a searchlight. The "illuminated region" consists of all those values of the parameters of physics for which we can determine with a reasonable degree of confidence whether or not they are life-permitting. Finally, let the bull's-eye of the dart board represent those values of the parameters of physics that we have good reason to believe are life-permitting. In terms of this dart board representation, to say that the parameters of physics are fine-tuned means that the bull's-eye must be small compared to the "illuminated region." For example, if we let S_0 represent the actual strength of the strong nuclear force between nucleons (i.e., protons or neutrons), and we know that the life-permitting range for this force is $[0.95S_0, 1.05S_0]$ whereas the total range of values for which we can confidently determine whether or not they are life-permitting is $[10^{-15}S_0, 10^{15}S_0]$, then clearly the one life-permitting range is very small compared to the total "illuminated" range and hence it follows that the strong nuclear force is fine-tuned.[(2)] Thus, under the way I am using the term, the "fine-tuning" *does not* include the fact that the parameters (and laws) of physics actually do fall within the known life-permitting range. (I shall call often call this latter fact the "existence of life-permitting cosmic conditions, " or *Lpc* for short.) However, it should be noted that when physicists and others speak of the "fine tuning," they usually include this latter fact as part of what they mean by the parameters of physics being fine-tuned. *For the rest of the paper, it is crucial to remember that in my use of the term it does not include the fact that the parameters of physics fall within the life-permitting range.*

Plan of the Chapter

Below, we will use the distinction introduced above between the atheistic single-universe hypothesis and the atheistic many-universes hypothesis to present two separate arguments for theism based on the fine-tuning: one which argues that, given the fine-tuning, the existence of life-permitting cosmic conditions provides strong reasons to prefer theism over the atheistic single-universe hypothesis and one which argues that we should prefer theism over the atheistic many-universes hypothesis as an explanation of the fine-tuning. We will develop the argument against the atheistic single-universe hypothesis in sections II - IV below, referring to it as the *core* argument. Then we will answer objections to this core argument in section V, develop the argument for preferring theism to the atheistic many-universes hypothesis in section VI, and finally in the concluding section argue that the core argument for preferring theism to the atheistic single-universe hypothesis is stronger than the probabilistic version of the atheist argument from the existence of evil.

II. CORE ARGUMENT RIGOROUSLY FORMULATED

General Principle of Reasoning Used

The Principle Explained

We will formulate the fine-tuning argument against the atheistic single-universe hypothesis in terms of what I will call the *prime principle of confirmation*. The prime principle of confirmation is a general principle of reasoning which tells us when some observation counts as evidence in favor of one hypothesis over another. *Simply put, the principle says that whenever we are considering two competing hypotheses, an observation counts as evidence in favor of the hypothesis under which the observation has the highest probability (or is the least improbable)*. (Or, put slightly differently, the principle says that whenever we are considering two competing hypotheses, H_1 and H_2, an observation, O, counts as evidence in favor of H_1 *over* H_2 if O is more probable under H_1 than it is under H_2.) Moreover, the degree to which the evidence counts in favor of one hypothesis over another is proportional to the degree to which the observation is more probable under the one hypothesis than the other.[(3)] For example, given the fine-tuning, the existence of life-permitting cosmic conditions is much, much more probable under the theism than under the atheistic single-universe hypothesis , so it counts as strong evidence for theism over this atheistic hypothesis. (Remember, the term "fine-tuning" is being used here in the technical sense I stipulated above.) In the next major subsection, we will present a more formal and elaborated rendition of the fine-tuning argument in terms of the prime principle. First, however, let's look at a couple of illustrations of the principle and then present some support for it.

Additional Illustrations of the Principle

For our first illustration, suppose that I went hiking in the mountains, and found underneath a certain cliff a group of rocks arranged in a formation that clearly formed the pattern "Welcome to the mountains Robin Collins." One hypothesis is that, by chance, the rocks just happened to be arranged in that pattern--ultimately, perhaps, because of certain initial conditions of the universe. Suppose the only viable alternative hypothesis is that my brother, who was in the mountains before me, arranged the rocks in this way. Most of us would immediately take the arrangements of rocks to be strong evidence in favor of the "brother" hypothesis over the "chance" hypothesis. Why? Because it strikes us as extremely *improbable* that the rocks would be arranged that way by chance, but *not improbable* at all that my brother would place them in that configuration. Thus, by the prime principle of confirmation we would conclude that the arrangement of rocks strongly supports the "brother" hypothesis over the chance hypothesis.

Or consider another case, that of finding the defendant's fingerprints on the murder weapon. Normally, we would take such a finding as strong evidence that the defendant was guilty. Why? Because we judge that it would be *unlikely* for these fingerprints to be on the murder weapon if the defendant was innocent, but *not unlikely* if the defendant was guilty. That is, we would go through the same sort of reasoning as in the above case.

Support for the Principle

Several things can be said in favor of the prime principle of confirmation. First, many philosophers think that this principle can be derived via Bayes's Theorem from what is known as the *probability calculus*, the set of mathematical rules that are typically assumed to govern probability. Second, there does not appear to be any case of recognizably good reasoning that violates this principle. Finally, the principle appears to have a wide range of applicability, undergirding much of our reasoning in science and everyday life, as the examples above illustrate. Indeed, some have even claimed that a slightly more specific version of this principle undergirds all scientific reasoning. Because of all these reasons in favor of the principle, we can be very confident in it.

Further Development of Argument

The Argument Stated

To further develop the core version of the fine-tuning argument, we will summarize the argument by explicitly listing its two premises and its conclusion:

> *Premise 1*. Given the fine-tuning, the existence of life-permitting cosmic conditions is *not* highly improbable under theism.
>
> *Premise 2.* Given the fine-tuning, the existence of life-permitting cosmic conditions is highly improbable under the atheistic single-universe hypothesis.
>
> *Conclusion*: From premises (1) and (2) and the prime principle of confirmation, it follows that, given the fine-tuning, the existence of life-permitting cosmic conditions provides significant evidence in favor of theism over the atheistic single-universe hypothesis.[(4)]

At this point, we should pause to note two features of this argument. First, the argument does not say that the existence of life-permitting cosmic conditions proves theism, or even that it is makes it likely that God exists. In order to justify these sorts of claims, we would have to look at the full range of evidence both for and against the theistic hypothesis, something we are not doing in this chapter. Rather, the argument merely concludes that because of the fine-tuning, the existence of life-permitting cosmic conditions significantly *supports* theism *over* the atheistic single-universe hypothesis.

In this way, the existence of life-permitting cosmic conditions counts as evidence for theism over the atheistic single-universe hypothesis in much the same way as fingerprints found on the gun can provide strong evidence that the defendant committed the murder. Although they provide strong evidence, one could not conclude merely from them alone that the defendant is guilty; one would also have to look at all the other evidence offered. Perhaps, for instance, ten reliable witnesses claimed to see the defendant at a party at the time of the shooting. In this case, the fingerprints would still count as significant evidence of guilt, but this evidence would be counterbalanced by the testimony of the witnesses. Similarly, given the fine-tuning, the existence of life-permitting cosmic conditions significantly supports theism over the atheistic single-universe hypothesis, though it does not itself show that everything considered theism is the most plausible explanation of the world. Nonetheless, as I argue in the conclusion of this chapter, the existence of life-permitting cosmic conditions provides a much stronger and more objective argument for theism (over the atheistic single-universe hypothesis) than the strongest atheistic argument does against theism.

The second feature of the argument we should note is that, given the truth of *the prime principle of confirmation*, the conclusion of the argument follows from the premises. Specifically, if the premises of the argument are true, then we are guaranteed that the conclusion is true: that is, the argument is what philosophers call *valid*. Thus, insofar as we can show that the premises of the argument are true, we will have shown that the conclusion is true. Our next task, therefore, is to attempt to show that the premises are true, or at least that we have strong reasons to believe them. We will do this immediately after discussing the nature of probability as used in the premises, and presenting a more precise version of them.

The Meaning of Probability in the Argument

The best way to understand the type of probability being invoked in the above argument is as *conditional epistemic probability*.[(5)] We will begin by defining epistemic probability *simpliciter*. *Epistemic probability* is a widely-recognized type of probability that applies to claims, statements, and hypotheses--that is, what philosophers call *propositions*. [(6)] Roughly, the epistemic probability of a proposition can be thought of as the degree of credence--that is, degree of confidence or belief--we rationally should have in the proposition. For example, when one says that the special theory of relativity is probably true, one is making a statement of epistemic probability. After all, the theory is actually either true or false. But, we do not know for sure whether it is true or false, so we say it is probably true to indicate that we should put more confidence in its being true than in its being false. It is also commonly argued that the probability of a coin toss is best understood as a case of epistemic probability. Since the side the coin will land on is determined by the laws of physics, it is argued that our assignment of probability is simply a measure of our rational expectations concerning which side the coin will land on.

Besides epistemic probability simpliciter, philosophers also speak of what is known as the *conditional* epistemic probability of one proposition on another. (A proposition is any claim, assertion, statement, or hypothesis about the world). The conditional epistemic probability of a proposition *R* on another proposition *S*--written as P(R/S)--can be defined as the degree to which the proposition *S of itself* should rationally lead us to expect that *R* is true.[(7)] For example, there is a high conditional probability that it will rain today on the hypothesis that the weatherman has predicted a 100% chance of rain, whereas there is a low conditional probability that it will rain today on the hypothesis that the weatherman has predicted only a 2% chance of rain. That is, the hypothesis that the weatherman has predicted a 100% chance of rain today should strongly lead us to expect that it will rain, whereas the hypothesis that the weatherman has predicted a 2% should lead us to expect that it will not rain.

Under the epistemic conception of probability, therefore, the statement that *given the fine-tuning, the existence of life-permitting cosmic conditions is not highly improbable under theism* (premise 1) is to be understood as making a statement about the degree to which theism conjoined with the claim that the universe is fine-tuned would or should, *of itself*, rationally lead us to expect life-permitting cosmic conditions; and correspondingly for premise (2). It should be noted here, however, that this rational degree of expectation should not be confused with the degree to which one should expect the parameters of physics to fall within the life-permitting range if one believes theism (or the atheistic single-universe hypothesis). For, both those who believe in theism and those who believe in the atheistic single-universe hypothesis should expect the parameters of physics to be life-permitting since this follows from the fact that we are alive. Rather, the conditional epistemic probability for premise (1) is the degree to which the conjunction of theism with the claim that universe is fine-tuned *of itself* should lead us to expect parameters of physics to be life-permitting, and correspondinglyfor premise (2). This means that in assessing the conditional epistemic probability in this and other similar cases, one must exclude contributions to our expectations arising from other information we have, such as that we are alive. In the case at hand, one way of doing this is by means of the following sort of thought experiment. Imagine a disembodied being who knows the universe is fine-tuned and who has mental capacities and a knowledge of physics comparable to that of the most intelligent physicists alive today, except that the being does not know whether the parameters of physics are within the life-permitting range. Further, suppose that this disembodied being

believed in theism. Then, the degree that being should rationally expect the parameters of physics to be life-permitting will be equal to our epistemic probability that the universe is life-permitting conditioned on theism and the claim that the universe is fine-tuned. That is, symbolically, its degree of belief will be equal to P(Lpc/T & Ft), where Lpc denotes the claim that the universe has life-permitting cosmic conditions, T denotes theism, and Ft denotes the claim that the universe is fine-tuned.[8] The reason for this is that its expectation that the universe has life-permitting cosmic conditions is solely a result of its belief in theism conjoined with its belief that the universe is fine-tuned, not other factors such as its awareness of its own existence. Similarly, if the disembodied being believed in the atheistic single-universe hypothesis, then its rational degree of belief that the universe has life-permitting cosmic conditions would be equal to P(Lpc/As & Ft), where As denotes the atheistic single-universe hypothesis.

More Precise Statement of Premises

Finally, it will be useful to state the above premises more precisely using the notion of conditional epistemic probability introduced above. Let Q be a number such that any probability greater than Q is not considered highly improbable, and any probability less than Q would qualify as highly improbable. Then, premise (1) asserts that the existence of life-permitting cosmic conditions has a probability, or range of probability, under theism that is greater than Q; similarly premise (2) asserts that the existence of life-permitting cosmic conditions has a probability, or range of probability, under the atheistic single-universe hypothesis that is less than Q. (A range will be said to be greater than Q if every member of the range is greater than Q.) Symbolically,

Premise (1): $P(Lpc/Ft \ \& \ T) > Q$, and

Premise (2): $P(Lpc/Ft \ \& \ As) < Q$.

The prime principle of confirmation then implies that Lpc confirms the conjunction of Ft & T over the conjunction of Ft & As, which in turn implies that Lpc confirms theism over the atheistic single-universe hypothesis.[9]

Support for the Premises

Basic Support for Premise (1)

Premise (1) is easy to support and fairly uncontroversial. One major argument in support of this proposition can be simply stated as follows: *since God is an all good being, and it is good for intelligent, conscious, embodied beings to exist, it not highly surprising or improbable that God would create a world that could support embodied intelligent life.* Thus, given the fine-tuning, the existence of life-permitting cosmic conditions is not improbable under theism, as premise (1) asserts. [10]

Support for Stronger Version of Premise (1)

So far we have argued that life-permitting cosmic conditions (Lpc) are not highly improbable under theism. But, all this implies is that Lpc confirms theism with respect to the atheistic single-universe hypothesis. It does not tell us the degree to which it confirms theism. Here, I will argue that P(Lpc/T & Ft) >= 0.5, and hence that Lpc *strongly* confirms theism over the atheistic single-universe hypothesis. (We will refer to this as the *strong version* of premise (1), and the corresponding argument as the *strong version* of the core fine-tuning argument.) The argument goes as follows:

Principle: Consider a state of affairs X and an agent S such that whether or not X occurs is completely up to S: that is, X occurs if and only if S decides to bring about X, and -X occurs if and only if S decides to bring about -X. (Here "-X" stands for not X.) If, to the best of our ability to determine, S has more reasons for bringing about X than -X, then P(*x*/*s*) >= P(-*x*/*s*), where *x* denotes the proposition that X is actualized, and *s* denotes the proposition that agent S exists and that X's occurrence is completely up to S. (The term "reasons" is being used here in the broad sense to include any motive that S might have to bring about X or -X.)

Argument for Principle: This principle seems to follow directly from the definition of conditional epistemic probability, which measures the rational degree of belief we should have in the truth of a proposition given we only consider as relevant the body of information on which it is being conditioned. Thus, in the above case, P(*x*/*s*) is the rational degree of belief we should have in X's occurrence given that the only relevant piece of information we are considering regarding X's occurrence is that agent S exists and that S has more reason to bring about X than -X. Since in this case the only grounds we have for believing that X or -X occurs is the degree of S's inclinations to bring about X or -X, and we believe that S has more inclination to bring about X than -X, it follows that we should be more confident that X occurs than -X occurs. Hence, P(*x*/*s*) >= P(-*x*/*s*).

Application of Principle: Let e' denote the claim that the state of affairs E' obtains, where E' denotes the state of affairs of the universe containing embodied, conscious beings whose overall existence is a positive good. Then, an all good God would have more reason to bring about E' than -E'. Thus, it follows from our principle that P(e'/T) >= P(-e'/T), and hence P(e'/T) > 0.5, where T is the proposition that an all good God exists and that the occurrence of e' is entirely up to God. *Now, e' entails Lpc, and hence P(Lpc/T) >= 0.5*.[(11)]

Finally, we need to show that P(Lpc/T & Ft) >= 0.5. To do this, we simply include Ft in our background information, and note that relative to Ft it is still the case that whether or not Lpc occurs is entirely up to God, and that we still have more reason to think that God would bring about Lpc than not Lpc. Thus, P(Lpc/T) >= 0.5 relative to background information Ft. But, P(Lpc/T) relative to information Ft is approximately equal to P(Lpc/T & Ft), and hence P(Lpc/T &Ft) is either approximately 0.5 or greater than 0.5.[(12)]

Basic Support for Premise (2)

Next, we need to support premise (2). Upon looking at the data, many people find it very obvious that given the fine-tuning, the existence of life-permitting cosmic conditions is highly improbable under the atheistic single-universe hypothesis. And it is easy to see why when we think of the fine-tuning in terms of the analogies offered earlier. In the dart-board analogy, for example, the initial conditions of the universe and the fundamental parameters of physics are thought of as a dart- board that fills the whole galaxy, and the conditions necessary for life to exist as a small one-foot wide bulls-eye. Accordingly, from this analogy it seems obvious that it would be highly improbable for the parameters of physics to fall within the life-permitting range under the atheistic single-universe hypothesis--that is, for the dart to hit the bulls-eye by chance.

Frequently, advocates the fine-tuning argument are satisfied with resting the justification of premise (2), or something like it, on this sort of analogy. Many atheists and theists, however, question the legitimacy of this sort of analogy, and thus find the argument unconvincing. For these people, the next section offers a rigorous and objective justification of premise (2) by means of commonly used principles of probabilistic reasoning.

III. RIGOROUS JUSTIFICATION OF PREMISE (2) OF CORE VERSION

In this section, we offer a rigorous support for premise (2) of the core version of the fine-tuning argument: that is, the claim that given the fine-tuning, the existence of life-permitting cosmic conditions is very improbable under the atheistic single-universe hypothesis. Our support for premise (2) will involve two major subsections. Our first subsection will be devoted to explicating the fine-tuning of gravity since we will often use this to illustrate our arguments. Then, in our second subsection, we will show how the improbability of existence of life-permitting cosmic conditions under the atheistic single-universe hypothesis can be derived from a commonly used principle of probabilistic reasoning called the *principle of indifference*.

i. The Example of Gravity

The force of gravity is determined by Newton's law $F = Gm_1m_2/r^2$. Here G is what is known as the *gravitational constant*, and is basically a number that determines the force of gravity in any given circumstance. For instance, the gravitational attraction between the moon and the earth is given by first multiplying the mass of the moon (m_1) times the mass of the earth (m_2), and then dividing by the distance between them squared (r^2). Finally, one multiplies this result by the number G to obtain the total force. Clearly the force is directly proportional to G: for example, if G were to double, the force between the moon and the earth would double.

In the previous section, we reported that some calculations indicate that the force of gravity must be fine-tuned to one part in 10^{40} in order for life to occur. What does such fine-tuning mean? To understand it, imagine a radio dial, going from 0 to $2G_0$, where G_0 represents the current value of the gravitational constant. Moreover, imagine the dial being broken up into 10^{40}--that is, ten thousand, billion, billion, billion, billion--evenly spaced tick marks. To claim that the strength of gravity must be fine-tuned to one part in 10^{40} is simply to claim that, in order for life to exist, the constant of gravity cannot vary by even one tick mark along the dial from its current value of G_0.

ii. The Principle of Indifference

In the following subsections, we will use the *principle of indifference* to justify the assertion that the existence of life-permitting cosmic conditions is highly improbable under the atheistic single-universe hypothesis.

a. The Principle Stated

Applied to cases in which there is a finite number of alternatives, the principle of indifference can be formulated as the claim that we should assign the same probability to what are called *equipossible alternatives*, where two or more alternatives are said to be equipossible if the amount of reason we have for believing any given alternative is the case is equal to the amount of reason we have for believing that any other alternative is the case.[(13)] For instance, in the case of a standard two-sided coin, we have the same amount of reason to think that the coin will land on heads as that it will land on tails, and so we assign them each an equal probability. Since the total probability must add up to one, this means that the coin has a 0.5 chance of landing on heads and an 0.5 chance of landing on tails. Similarly, in the case of a standard six-sided die, we have the same amount of reason to think that it will land on one number, say a 6, as any of the other number, such as a 4. Thus, the principle of indifference tells us to assign each possible way of landing an equal probability--namely 1/6.

The above explication of the principle applies only when there are a finite number of alternatives, for example six sides on a die. In the case of the fine-tuning, however, the alternatives are not finite but form a continuous magnitude. The value of G, for instance, conceivably could have been any number between 0 and infinity. Now, continuous magnitudes are usually thought of in terms of ranges, areas, or volumes depending on whether or not we are considering one, two, three or more dimensions. For example, the amount of water in a 8oz glass could fall anywhere within the *range* 0oz to 8oz, such as 6.012345645oz. Or, the exact position that a dart hits a dart board can fall anywhere within the *area* of the dart board. For convenience, however, we shall also call such areas and volumes "ranges." With some qualifications to be discussed below, the principle of indifference becomes in the continuous case the principle that *when we have no reason to prefer any one range of a parameter over any other except for the size of the range, we should assign equal probabilities to ranges of equal size.* The idea behind this version of the principle is that a relevant reason for believing a parameter will fall in a certain range is the size of that range. Thus, in the absence of any other relevant reasons, it follows that if the sizes of a countable set of ranges are all equal, we have the same amount of reason to believe that it will fall in any given range as any other. Accordingly, the principle of indifference for the discrete case implies that we should assign equal ranges equal probabilities. So, for instance, suppose one aimlessly throws a dart at a dart board. Assuming the dart hits the board, what is the probability it will hit within the bull's-eye? Since the dart is thrown aimlessly, we have no more reason to believe it will hit one region of the dart board than any other region of equal size. The principle of indifference for the continuous case, therefore, tells us that the probability of its hitting the bull's-eye is the same as the probability of hitting any other part of the dart board of equal area. This means that the probability of it hitting the bull's-eye is simply the ratio of the area of the bull's-eye to the rest of the dart board. So, for instance, if the bull's-eye forms only 5% of the total area of the board, then the probability of its hitting the bull's-eye will be 5%.

b. Application to Fine-Tuning

In the case of the fine-tuning, we have no more reason to think that the parameters of physics will fall within the life-permitting range than the any other range of equal size, given the atheistic single-universe hypothesis. Thus according to the principle of indifference, equal ranges of these parameters should be assigned equal probabilities. As in the case of the dart board mentioned in the last subsection, this means that the probability of the parameters of physics falling within the life-permitting range under the atheistic single-universe hypothesis is simply the ratio of the range of life-permitting values (the "area of the bull's-eye") to the total *relevant* range of possible values (the "relevant area of the dart board").

Now physicists can make rough estimates of the range of *life-permitting* values for the parameters of physics, as discussed above in the case of gravity, for instance. But what is the "total *relevant* range of possible values"? At first one might think that this range is infinite, since the values of the parameters could conceivably be anything. This, however, is not correct, for although the possible range of values could be infinite, for most of these values we have no way of estimating whether they are life-permitting or not. We do not truly know, for example, what would happen if gravity were 10^{60} times stronger than its current value: as far as we know, a new form a matter might come into existence that could sustain life. Thus, as far as we know, there could be other life-permitting ranges far removed from the actual values that the parameters have. Consequently, all we can say is that the life-permitting range is very, very small *relative* to the limited range of values for which we can make estimates, a range that we have referred to as the "*illuminated*" range.

Fortunately, however, this limitation does not undercut the overall argument. The reason is that, based on the principle of indifference, we can still say that it is very improbable for the values for the parameters of physics to have fallen in the life-permitting range *instead* of some other part of the "illuminated" range. And this *improbability* is all that is actually needed for our main argument to work. To see this, consider an analogy. Suppose a dart landed on the bull's-eye at the center of a huge dart board. Further, suppose that this bull's-eye is surrounded by a very large empty, bulls-eye-free, area. Even if there were many other bull's-eyes on the dart board, we would still take the fact that the dart landed on the bull's-eye instead of some other part of the large empty area surrounding the bull's-eye as strong evidence that it was aimed. Why? Because we would reason that *given that the dart landed in the empty area*, it was very improbable for it to land in the bull's-eye by chance but not improbable if it were aimed. [(14)] Thus, by the prime principle of confirmation, we could conclude that the dart landing on the bull's-eye strongly confirms the hypothesis that is was aimed over the chance hypothesis.

c. The Principle Qualified:

Those who are familiar with the principle of indifference, and mathematics, will recognize that one important qualification needs to be made to the above account of how to apply the principle of indifference. (Those who are not mathematically adept might want to skip this and perhaps the next paragraph.) To understand the qualification, note that the ratio of ranges used in calculating the probability is dependent on how one parameterizes, or writes, the physical laws. For example, suppose for the sake of illustration that the range of life-permitting values for the gravitational constant is 0 to G_0, and the "illuminated" range of possible values for G is 0 to $2G_0$. Then, the ratio of life-permitting values to the range of "illuminated" possible values for the gravitational constant will be ½. Suppose, however, that one writes the law of gravity in the mathematically equivalent form of $F = \text{square root}[U]m_1m_2/r^2$, instead of $F=Gm_1m_2/r^2$, where $U=G^2$. (In this way of writing Newton's law, U becomes the new gravitational constant.) This means that $Uo = G_0^2$, where Uo, like G_0, represents the actual value of U in our universe. Then, the range of life-permitting values would be 0 to Uo, and the "illuminated" range of possible values would be 0 to 4Uo on the U scale (which is equivalent to 0 to $2G_0$ on the G scale). Hence, calculating the ratio of life-permitting values using the U scale instead of G scale yields a ratio of 1/4 instead of ½. Indeed, for almost any ratio one chooses --such as one in which the life-permitting range is about the same size as the "illuminated" range--there exist mathematically equivalent forms of Newton's law that will yield that ratio. So, why choose the standard way of writing Newton's law to calculate the ratio instead of one in which G's falling within the life-permitting range is not improbable at all?

The answer to this question is to require that the proportion used in calculating the probability be between *real* physical ranges, areas, or volumes, not merely mathematical representations of them. That is, the proportion given by the scale used in one's representation must directly correspond to the proportions actually existing in physical reality. As an illustration, consider how we might calculate the probability that a meteorite will fall in New York state instead of somewhere else in the northern, contiguous United States. One way of doing this is to take a standard map of the northern, contiguous United States, measure the area covered by New York on the map (say 2 square inches) and divide it by the total area of the map (say 30 square inches). If we were to do this, we would get approximately the right answer because the proportions on a standard map directly correspond to the actual proportions of land areas in the United States.[(15)] On the

other hand, suppose we had a map made by some lover of the East coast in which, because of the scale used, the East coast took up half the map. If we used the proportions of areas as represented by this map we would get the wrong answer since the scale used would not correspond to real proportions of land areas. Applied to the fine-tuning, this means that our calculations of these proportions must be done using parameters that directly correspond to physical quantities in order to yield valid probabilities. In the case of gravity, for instance, the gravitational constant G directly corresponds to the force between two unit masses a unit distance apart, whereas U does not. (Instead, U corresponds to the square of the force.) Thus, G is the correct parameter to use in calculating the probability.[(16)]

d. Support for Principle

Finally, although the principle of indifference has been criticized on various grounds, several powerful reasons can be offered for its soundness if it is restricted in the ways explained in the last subsection. First, it has an extraordinarily wide range of applicability. As Roy Weatherford notes in his book, Philosophical Foundations of Probability Theory, "an astonishing number of extremely complex problems in probability theory have been solved, and usefully so, by calculations based entirely on the assumption of equiprobable alternatives [that is, the principle of indifference]"(p. 35).

Second, at least for the case in which there are a discrete number of alternatives, the principle follows directly from what we mean by the probability in the fine-tuning argument, namely *epistemic probability*.[(17)] The argument is straightforward. First, we recall that according to the definition of epistemic probability given above, the epistemic probability of a proposition can be thought of as the degree of credence--that is, degree of confidence or belief--we rationally should have in the proposition. Second, we introduce the following assumption:

Assumption 1: The rational degree of belief we should have in a claim is equal to the *rational grounds* we have for the claim. (That is, the *warrant* and *justification* we have for the claim on certain epistemologies.)

By *Assumption 1* and the definition of epistemic probability, it follows that *for any two alternatives A and B, if we have the same amount of reason to believe A as B (that is, we have the same rational grounds for believing A as for believing B), then the epistemic probability of A is the same as the epistemic probability of B.* This latter italicized statement, however, is simply the principle of indifference in the discrete case for epistemic probability.[(18)]

Finally, in certain everyday cases the principle of indifference seems the only justification we have for assigning probability. To illustrate, suppose that in the last ten minutes a factory produced the first fifty-sided die ever produced. Further suppose that every side of the die is macroscopically perfectly symmetrical with every other side, except for there being different numbers printed on each side. (The die we are imagining is like a fair six-sided die except that it has fifty sides instead of six.) Now, we all immediately know that upon being rolled the probability of the die coming up on any given side is one in fifty. Yet, we do not know this directly from experience with fifty-sided dies, since by hypothesis no one has yet rolled such dies to determine the relative frequency with which they come up on each side. Rather, it seems our only justification for assigning this probability is the principle of indifference: that is, given that every side of the die is relevantly macroscopically symmetrical with every other side, we have the same amount of reason to believe that the die will land on any given side as we have for believing it will land on any other side, and thus we assign them all an equal probability of one in fifty. [(19)]

IV: CONCLUSION OF CORE VERSION

In the above core version of the fine-tuning argument, we showed that relative to the background information Ft and IL, the fact that the universe has life-permitting cosmic conditions gives us significant (or strong) reasons for preferring theism over the atheistic single-universe hypothesis.

Often, however, this idea of a body of data E being evidence for an hypothesis H can be usefully spelled out in terms of the change in the degree of belief a rational person should have in H upon learning E. The idea is that if E supports H then we should have more confidence in H after learning E than before. For the sake of providing alternative ways of understanding our conclusion, we will suggest two ways of doing this here, though the soundness of our conclusion is in no way dependent on validity of these alternative understandings.

To spell out our conclusion in terms of rational change in belief, we first need to write the confirmation relation as

Eq. (1): P(T/Ft & IL & Lpc)/P(As/Ft & IL & Lpc) > P(T/Ft & IL)/P(As/Ft & IL),

where this equation follows from premise (1) and premise (2) of our core argument using the odds form of Bayes's theorem.[(20)] (Here, IL denotes the claim that the parameters of physics have fallen into the "illuminated" range, as discussed in section III-iib above.)

Clearly, we cannot interpret Eq. (1) as telling us how a rational human being's relative confidence in T versus As should change upon learning Lpc, since as pointed out above, all rational human beings must believe Lpc since it follows from our own existence. We can, however, spell this out in terms of the change in the relative degrees of belief of the disembodied alien observer with comparable epistemic faculties that we introduced in section III when we defined conditional epistemic probability. Specifically, the ratio of this observer's rational degree of belief in T to its rational degree of belief in As should increase learning Lpc, with the increase being very large in the case of the *strong* version our argument.

Finally, we can understand this confirmation relation in terms of how our rational degree of belief should change upon learning that the universe is fine-tuned: that is, upon learning that the life-permitting range is small compared to the "illuminated" range. Specifically, *upon learning that the universe is fine-tuned, the ratio of our rational degree of belief in T to our rational degree in As should increase, the increase being very large in the case of the strong version of our argument*. The argument for this conclusion begins by recognizing that in the context of our argument, it is really Ft conjoined with Lpc that confirms T over As: that is, neither Ft nor Lpc alone confirms T over As. Ft alone does not confirm because the mere fact that a universe is fine-tuned does not itself seem to be improbable under the atheistic single-universe hypothesis, and Lpc alone does not confirm because Lpc is only improbable under the atheistic single-universe hypothesis because the known region of life-permitting values is believed to be small compared to the known region of non-life permitting values. Put symbolically, P(T/IL & Ft)/P(As/IL & Ft) P(T/IL)/P(As/IL) and P(T/IL & Lpc)/P(As/IL & Lpc) P(T/IL)/P(As/IL). It follows from Eq (1) above and these relations, however, that Ft confirms theism over the atheistic single-universe hypothesis:

P(T/Ft & IL & Lpc)/P(As/Ft & IL & Lpc) > P(T/IL & Lpc)/P(As/IL & Lpc)

Thus, we can think of the fine-tuning argument as claiming that the discovery of the fine-tuning of the cosmos confirms theism over the atheistic single universe hypothesis, and thus that this discovery should raise our confidence in theism relative to this atheistic single-universe hypothesis.

V. SOME OBJECTIONS TO CORE VERSION

In this section, we will consider some common objections to the fine-tuning argument and show that the core version of the argument presented above can easily answer these objections.

Objection 1: More Fundamental Law Objection

One criticism of the fine-tuning argument is that, as far as we know, there could be a more fundamental law under which the parameters of physics *must* have the values they do. Thus, given such a law, it is not improbable that the known parameters of physics fall within the life-permitting range.

Besides being entirely speculative, the problem with postulating such a law is that it simply moves the improbability of the parameters of phsics falling into the life-permitting range up one level, to that of the postulated physical law itself. Under this hypothesis, what is improbable is that all the conceivable fundamental physical laws there could be, the universe just happens to have the one that constrains the parameters of physics in a life-permitting way. Thus, trying to explain the fine-tuning by postulating this sort of fundamental law is like trying to explain why the pattern of rocks below a cliff spell "Welcome to the mountains Robin Collins" by postulating that an earthquake occurred and that all the rocks on the cliff face were arranged in just the right configuration to fall into the pattern in question. Clearly this explanation merely transfers the improbability up one level, since now it seems enormously improbable that of all the possible configurations the rocks could be in on the cliff face, they are in the one which results in the pattern "Welcome to the mountains Robin Collins."

A similar sort of response can be given to the claim that the existence of life-permitting cosmic conditions is not improbable because it might be *logically necessary* for the parameters of physics to have life-permitting values. That is, according to this claim, the parameters of physics must have life-permitting values in the same way 2 + 2 must equal 4, or the interior angles of a triangle must add up to 180 degrees in Euclidian geometry. Like the "more fundamental law" proposal above, however, this postulate simply transfers the improbability up one level: of all the laws and parameters of physics that conceivably could have been logically necessary, it seems highly improbable that it would be those that are life-permitting.[(21)]

Objection 2: Other Forms of Life Objection

Another objection people commonly raise to the fine-tuning argument is that as far as we know, other forms of life could exist even if the parameters of physics were different. So, it is claimed, the fine-tuning argument ends up presupposing that all forms of intelligent life must be like us. The answer to this

objection is that most cases of fine-tuning do not make this presupposition. Consider, for instance, the case of the fine-tuning of the strong nuclear force. If it were slightly smaller, no atoms could exist other than hydrogen. Contrary to what one might see on *Star Trek*, an intelligent life form cannot be composed merely of hydrogen gas: there is simply not enough stable complexity. So, in general the fine-tuning argument merely presupposes that intelligent life requires some degree of stable, reproducible organized complexity. This is certainly a very reasonable assumption.

Objection 3. **Anthropic Principle Objection**:

According to the weak version of so-called *anthropic principle*, if the laws of nature were not fine-tuned, we would not be here to comment on the fact. Some have argued, therefore, that the parameters of physics falling within the life-permitting range is not really *improbable or surprising* at all under atheism, but simply follows from the fact that we exist. The response to this objection is to simply restate the argument in terms of our existence, as we typically did for convenience above: our existence as embodied, intelligent beings is extremely unlikely under the atheistic single-universe hypothesis (since our existence requires fine-tuning), but not improbable under theism. Then, we simply apply the prime principle of confirmation to draw the conclusion that *our existence* significantly confirms theism over the atheistic single-universe hypothesis.

To further illustrate this response, consider the following "firing-squad" analogy. As John Leslie (1988, p. 304) points out, if fifty sharp shooters all miss me, the response "if they had not missed me I wouldn't be here to consider the fact" is not adequate. Instead, I would naturally conclude that there was some reason why they all missed, such as that they never really intended to kill me. Why would I conclude this? Because my continued existence would be very improbable under the hypothesis that they missed me by chance, but not improbable under the hypothesis that there was some reason why they missed me. Thus, by the prime principle of confirmation, my continued existence significantly confirms the latter hypothesis.

Objection 4: Many Possible Life-Permitting Conditions Objection

Some object to the fine-tuning argument by claiming that as far as we know, the existence of other life-permitting cosmic conditions could be fairly common, an hypothesis that we shall call the Many Life-Permitting Conditions hypothesis. (MLP for short). Going back to our dart board analogy to the parameters (and laws) of physics, the MLP hypothesis is claiming that the proportion of the dart board covered by bull's-eyes is not exceedingly small. We simply happen to live in an exceptional region that is "fine-tuned": that is, a region that is life-permitting but is surrounded by a region of non-life-permitting values of the parameters of physics that is exceedingly large in comparison. Thus the objection goes, if the MLP is true, the existence of life-permitting cosmic conditions could actually be very probable under the atheistic single-universe hypothesis.

Two replies can be given to this objection. The first reply is simply to include the fact Ft that the universe is fine-tuned, along with the fact, IL, that the parameters of physics are in the "illuminated" region, as part of the information being conditioned on. That is, premise (1) becomes P(Lpc/Ft & IL & T) >Q and premise (2) becomes P(Lpc/Ft & IL & As) < Q, and then one simply applies the prime principle of confirmation as

before. Whether MLP is true then becomes irrelevant, because the truth of premise (2) hinges upon the *relative* ratio of the life-permitting range to the total "illuminated" range, and this ratio is the same whether or not MLP is true. (Remember that the "illuminated" region was previously defined as the region consisting of all those values of the parameters of physics for which we can determine with a reasonable degree of confidence whether or not they are life-permitting; Also, see section III, subsection ii-b for a more intuitive treatment of this reply.)

Now for the second reply, which might be a little difficult to follow. The second reply begins by noting that given that MLP is true, and given that life-permitting cosmic conditions have occurred, it would be very unlikely for these conditions to occur in a "fine-tuned" bull's-eye: that is, a bull's-eye surrounded by an exceedingly large non-life permitting region. The reason for this is that, under MLP, fine-tuned bull's-eyes must be fairly rare. For suppose that this were not the case. That is, suppose that a significant percentage--say 1%--of the region covered by bull's-eyes consisted of fine-tuned bull's-eyes. Then, the area covered by bull's-eyes would be about 100 times the size of the region covered by the fine-tuned bull's-eyes. But by the definition of a "fine-tuned bull's-eye," it follows that the union of the regions of non-life-permitting values surrounding the fine-tuned bull's-eyes must be *exceedingly* larger than the region covered by the fine-tuned bull's-eyes. This in turn implies that the union of non-life-permitting regions must be exceedingly larger than the total region covered by all the bull's-eyes, thus contradicting the MLP hypothesis.[(22)] Thus, it follows from MLP (and the atheistic single-universe hypothesis) that if the parameters of physics fall within a bull's-eye (i.e, a life-permitting region), it is much, much more likely that they will into a non-fined-tuned bull's-eye than a fine-tuned one. That is, the probability of the universe being fine-tuned under MLP, Lpc, and the atheistic single-universe hypothesis is very small: P(Ft/MLP & Lpc & As) is very, very small. But, the probability of the universe being fine-tuned under the denial of MLP (and Lpc and As) is not small: P(Ft/-MLP & Lpc & As) is not small. Thus, it follows by the prime principle of confirmation that the existence of the fine-tuning strongly disconfirms the hypothesis, MLP, that there are many life-permitting regions.

Objection 5: The "Who Designed God?" Objection

Perhaps the most common objection that atheists raise to the argument from design, of which the fine-tuning argument is one instance, is that postulating the existence of God does not solve the problem of design, but merely transfers it up one level. Atheist George Smith, for example, claims that

> If the universe is wonderfully designed, surely God is even more wonderfully designed. He must, therefore, have had a designer even more wonderful than He is. If *God* did not require a designer, then there is no reason why such a relatively less wonderful thing as the universe needed one. (1980, p. 56.)

Or, as philosopher J. J. C. Smart states the objection:

> If we postulate God in addition to the created universe we increase the complexity of our hypothesis. We have all the complexity of the universe itself, and we have in addition the at least equal complexity of God. (The designer of an artifact must be at least as complex as the designed

artifact) . . . .*If the theist can show the atheist that postulating God actually reduces the complexity of one's total world view, then the atheist should be a theist*. (pp. 275-276; italics mine)

The first response to the above atheist objection is to point out that the atheist claim that the designer of an artifact must be as complex as the artifact designed is certainly not obvious. But I do believe that their claim has some intuitive plausibility: for example, in the world we experience, organized complexity seems only to be produced by systems that already possess it, such as the human brain/mind, a factory, or an organisms' biological parent.

The second, and better, response is to point out that, at most, the atheist objection only works against a version of the design argument that claims that all organized complexity needs an explanation, and that God is the best explanation of the organized complexity found in the world. The version of the argument I presented against the atheistic single-universe hypothesis, however, only required that the existence of life-permitting cosmic conditions to be more probable under theism than under the atheistic single-universe hypothesis. But this requirement is still met even if God exhibits tremendous internal complexity, far exceeding that of the universe. Thus, even if we were to grant the atheist assumption that the designer of an artifact must be as complex as the artifact, the existence of life-permitting cosmic conditions would still give us strong reasons to prefer theism over the atheistic single-universe hypothesis.

To illustrate, consider the example of the "biosphere" on Mars presented at the beginning of this paper. As mentioned above, the existence of the biosphere would be much more probable under the hypothesis that intelligent life once visited Mars than under the chance hypothesis. Thus, by the prime principle of confirmation, the existence of such a "biosphere" would constitute strong evidence that intelligent, extraterrestrial life had once been on Mars, even though this alien life would most likely have to be much more complex than the "biosphere" itself.

The final response theists can give to this objection is to show that a supermind such as God would *not* require a high degree of unexplained organized complexity to create the universe. Although I have presented this response elsewhere (unpublished manuscript), presenting it here is beyond the scope of this chapter.

VI. THE ATHEISTIC MANY-UNIVERSES HYPOTHESIS

The Atheistic Many-Universes Hypothesis Explained

In response to theistic explanation of the fact that the parameters of physics fall within the life-permitting range, many atheists have offered an alternative explanation, what I will call the atheistic many-universes hypothesis. (In the literature it is more commonly refereed to in the *Many Worlds hypothesis*, though I believe this name is somewhat misleading.) According to this hypothesis, there are a very large--perhaps infinite --number of universes, with the fundamental parameters of physics varying from universe to universe.[(23)] Of course, in the vast majority of these universes the parameters of physics would not have life-permitting values. Nonetheless, in a small proportion of universes they would, and consequently it is no longer improbable that universes such as ours exist that are fine-tuned for life to occur.

Advocates of this hypothesis offer various types of models for where these universes came from. We will present what are probably the two most popular and plausible, the so-called *vacuum fluctuation* models and the *oscillating Big Bang* models. According to the vacuum fluctuation models, our universe, along with these other universes, were generated by quantum fluctuations in a pre-existing superspace (e.g., see Quentin Smith, 1986, p. 82). Imaginatively, one can think of this pre-existing superspace as a infinitely

extending ocean full of soap, and each universe generated out of this superspace as a soap-bubble which spontaneously forms on the ocean.

The other model, the oscillating Big Bang model, is a version of the *Big Bang* theory. According to the Big Bang theory, the universe came into existence in an "explosion" (that is, a "bang") somewhere between 10 and 15 billion years ago. According to the *oscillating* Big Bang theory, our universe will eventually collapse back in on itself (what is called the "Big Crunch") and then from that "Big Crunch" will arise another "Big Bang", forming a new universe, which will in turn itself collapse, and so on. According to those who use this model to attempt to explain the existence of life-permitting cosmic conditions, during every cycle, the parameters of physics and the initial conditions of the universe are reset at random. Since this process of collapse, explosion, collapse, and explosion has been going on for all eternity, eventually a fine-tuned universe will occur, indeed infinitely many of them.

In the next section, we will list several reasons for rejecting atheistic many-universes hypothesis.

Reasons for Rejecting the Atheistic Many-Universes Hypothesis

First Reason:

The first reason for rejecting the atheistic many-universes hypothesis, and preferring the theistic hypothesis, is the following general rule: *everything else being equal, we should prefer hypotheses for which we have independent evidence or that are natural extrapolations from what we already know.* Let's first illustrate and support this principle, and then apply it to the case of the fine-tuning.

Most of us take the existence of dinosaur bones to count as very strong evidence that dinosaurs existed in the past. But suppose a dinosaur skeptic claimed that she could explain the bones by postulating a "dinosaur-bone-producing-field" that simply materialized the bones out of thin air. Moreover, suppose further that, to avoid objections such as that there are no known physical laws that would allow for such a mechanism, the dinosaur skeptic simply postulated that we have not yet discovered these laws or detected these fields. Surely, none of us would let this skeptical hypothesis deter us from inferring to the existence of dinosaurs. Why? Because although no one has directly observed dinosaurs, we do have experience of other animals leaving behind fossilized remains, and thus the dinosaur explanation is a *natural extrapolation* from our common experience. In contrast, to explain the dinosaur bones, the dinosaur skeptic has invented a set of physical laws, and a set of mechanisms that are *not* a natural extrapolation from anything we know or experience.

In the case of the fine-tuning, we already know that minds often produce fine-tuned devices, such as Swiss watches. Postulating God--a supermind--as the explanation of the parameters of physics falling in the life-permitting range, therefore, is a natural extrapolation from of what we already observe minds to do. In contrast, it is difficult to see how the atheistic many-universes hypothesis could be considered a natural extrapolation from what we observe. Moreover, unlike the atheistic many-universes hypothesis, we have some independent evidence for the existence of God, such as religious experience. Thus, by the above principle, we should prefer the theistic explanation of the parameters of physics falling within the life-permitting range over the atheistic many-universes explanation, everything else being equal.

Second Reason:

A second reason for rejecting the atheistic many-universe hypothesis is that the "many-universes generator" seems like it would need to be designed. For instance, in all current worked-out proposals for what this "universe generator" could be--such as the oscillating big bang and the vacuum fluctuation models explained above--the "generator" itself is governed by a complex set of physical laws that allow it to produce the universes. It stands to reason, therefore, that if these laws were slightly different the generator probably would not be able to produce any universes that could sustain life. After all, even my bread machine has to be made just right in order to work properly, and it only produces loaves of bread, not universes! Or consider a device as simple as a mouse trap: it requires that all the parts, such as the spring and hammer, be arranged just right in order to function. It is doubtful, therefore, whether the atheistic many-universe theory can entirely eliminate the problem of design the atheist faces; rather, at least to some extent, it seems simply to move the problem of design up one level. [(24)]

Third Reason:

A third reason for rejecting the atheistic many-universes hypothesis is that the universe generator must not only select the parameters of physics at random, but must actually randomly create or select the very laws of physics themselves. This makes this hypothesis seem even more far-fetched since it is difficult to see what possible physical mechanism could select or create laws.

The reason the "many-universes generator" must randomly select the laws of physics is that, just as the right values for the parameters of physics are needed for life to occur, the right set of laws is also needed. If, for instance, certain laws of physics were missing, life would be impossible. For example, without the law of inertia, which guarantees that particles do not shoot off at high speeds, life would probably not be possible (Leslie, Universes, p. 59). Another example is the law of gravity: if masses did not attract each other, there would be no planets or stars, and once again it seems that life would be impossible. Yet another example is the *Pauli Exclusion Principle*, the principle of quantum mechanics that says that no two fermions--such as electrons or protons--can share the same quantum state. As prominent Princeton physicist Freeman Dyson points out [*Disturbing the Universe*, p. 251], without this principle all electrons would collapse into the nucleus and thus atoms would be impossible.

Fourth Reason:

The fourth reason for rejecting the atheistic many-universes hypothesis is that it cannot explain other features of the universe that seem to exhibit apparent design, whereas theism can. For example, many physicists, such as Albert Einstein, have observed that the basic laws of physics exhibit an extraordinary degree of beauty, elegance, harmony, and ingenuity. Nobel Prize winning physicist Steven Weinberg, for instance, devotes a whole chapter of his book Dreams of a Final Theory (Chapter 6, "Beautiful Theories") explaining how the criteria of beauty and elegance are commonly used to guide physicists in formulating the right laws. Indeed, one of most prominent theoretical physicists of this century, Paul Dirac, went so far as to claim that "it is more important to have beauty in one's equations than to have them fit experiment." (1963, p. ??).

Now such beauty, elegance, and ingenuity make sense if the universe was designed by God. Under the atheistic many-universes hypothesis, however, there is no reason to expect the fundamental laws to be elegant or beautiful. As theoretical physicist Paul Davies writes, "If nature is so 'clever' as to exploit mechanisms that amaze us with their ingenuity, is that not persuasive evidence for the existence of intelligent design behind the universe? If the world's finest minds can unravel only with difficulty the deeper workings of nature, how could it be supposed that those workings are merely a mindless accident, a product of blind chance?" (Superforce, pp. 235-36.)

Final Reason

This brings us to the final reason for rejecting the atheistic many-universes hypothesis, which may be the most difficult to grasp: namely, neither the atheistic many-universes hypothesis (nor the atheistic single-universe hypothesis) can at present adequately account for the improbable initial arrangement of matter in the universe required by the second law of thermodynamics. To see this, note that according to the second law of thermodynamics, the entropy of the universe is constantly increasing. The standard way of understanding this entropy increase is to say that the universe is going from a state of order to disorder. We observe this entropy increase all the time around us: things, such as a child's bedroom, that start out highly organized tend to "decay" and become disorganized unless something or someone intervenes to stop it.

Now, for purposes of illustration, we could think of the universe as a scrabble-board that initially starts out in a highly ordered state in which all the letters are arranged to form words, but which keeps getting randomly shaken. Slowly, the board, like the universe, moves from a state of order to disorder. The problem for the atheist is to explain how the universe could have started out in a highly ordered state, since it is extraordinarily improbable for such states to occur by chance.[(25)] If, for example, one were to dump a bunch of letters at random on a scrabble-board, it would be very unlikely for most of them to form into words. At best, we would expect groups of letters to form into words in a few places on the board.

Now our question is, Could the atheistic many-universes hypothesis explain the high degree of initial order of our universe by claiming that given enough universes, eventually one will arise that is ordered and in which intelligent life occurs, and so it is no surprise that we find ourselves in an ordered universe? The problem with this explanation is that it is overwhelmingly more likely for local patches of order to form in one or two places than for the whole universe to be ordered, just as it is overwhelmingly more likely for only a few words on the scrabble-board randomly to form words than for all the letters throughout the board randomly to form words. Thus, the overwhelming majority of universes in which intelligent life occurs will be ones in which the intelligent life will be surrounded by a small patch of order necessary for its existence, but in which the rest of the universe is disordered. Consequently, even under the atheistic many-universes hypothesis, it would still be enormously improbable for intelligent beings to find themselves in a universe such as ours which is highly ordered throughout. (See Sklar, chapter 8 for a review of the non-theistic explanations for the ordered arrangement of the universe and the severe difficulties they face.)

Conclusion

Even though the above criticisms do not definitively refute the atheistic many-universes hypothesis, they do show that it has some severe disadvantages relative to theism. This means that if atheists adopt the atheistic many-universes hypothesis to defend their position, then atheism has become much less plausible than it used to be. Modifying a turn of phrase coined by philosopher Fred Dretske: these are inflationary times, and the cost of atheism has just gone up.

VII. OVERALL CONCLUSION

In the above sections we showed we have good, objective reasons for claiming that given the fine-tuning, the existence of life-permitting cosmic conditions provides strong evidence for theism. We first presented an argument for thinking that the existence of life-permitting cosmic conditions provides strong evidence for preferring theism over the atheistic single-universe hypothesis, and then presented a variety of different reasons for rejecting the atheistic many-universes hypothesis as an explanation for the fact that the parameters of physics fall within the life-permitting range. In order to help one appreciate the strength of the arguments we presented, I would like to end by comparing the strength of the *core* version of the argument from the fine-tuning to what is widely regarded as the strongest atheist argument against theism, the argument from evil. [(26)]

Typically, the atheist argument against God based on evil takes a similar form to the core version of the fine-tuning argument. Essentially, the atheist argues that the existence of the kind of evils we find in the world is very improbable under theism, but not improbable under atheism. Thus, by the prime principle of confirmation, they conclude that the existence of evil provides strong reasons for preferring atheism over theism.

What makes this argument weak in comparison to the core version of the fine-tuning argument is that, unlike in the case of the fine-tuning, the atheist does not have a significant objective basis for claiming that the existence of the kinds of evil we find in the world is highly improbable under theism. In fact, their judgment that it is improbable seems largely to rest on a mistake in reasoning. To see this, note that in order to show that it is improbable, atheists would have to show that it is *unlikely* that the types of evils we find in the world are necessary for any morally good, greater purpose, since if they are, then it is clearly not at all unlikely that an all good, all powerful being would create a world in which those evils are allowed to occur. But how could atheists show this without first surveying all possible morally good purposes such a being might have, something they have clearly not done? *Consequently, it seems, at most the atheist could argue that since no one has came up with any adequate purpose yet, it is unlikely that there is such a purpose*. This argument, however, is very weak, as I will now argue.

The first problem with this atheist argument is that it assumes that the various explanations people have offered for why an all good God would create evil--such as the free will theodicy--ultimately fail. But even if we grant that these theodicies fail, the argument is still very weak. To see why, consider an analogy. Suppose someone tells me that there is a rattlesnake in my garden, and I examine a portion of the garden and do not find the snake. I would only be justified in concluding that there was probably no snake in the garden if either: i) I had searched at least half the garden; or ii) I had good reason to believe that if the snake were in the garden, it would likely be in the portion of the garden that I examined. If, for instance, I were to randomly pick some small segment of the garden to search and did not find the snake, I would be unjustified in concluding from my search that there was probably no snake in the garden. Similarly, if I were blindfolded and did not have any idea of how large the garden was (e.g., whether it was ten square feet or several square miles), I would be unjustified in concluding that it was unlikely that there was a rattlesnake in the garden, even if I had searched for hours with my rattlesnake detecting dogs. Why? Because I would not have any idea of what percentage of the garden I had searched.

As with the garden example, we have no idea of how large the realm is of possible greater purposes for evil that an all good, omnipotent being could have. Hence we do not know what proportion of this realm we have actually searched. Indeed, considering the finitude of our own minds, we have good reason to believe that we have so far only searched a small proportion, and we do not have sufficient reason to believe that all the purposes God might have for evil would be in the proportion we searched. Thus, we have little objective basis for saying that the existence of the types of evil we find in the world is highly improbable under theism.

From the above discussion, therefore, it is clear that the relevant probability estimates in the case of the fine-tuning are much more secure than those estimates in the probabilistic version of the atheist's argument from evil, since unlike the latter, we can provide an objective basis for them using actual calculations of the relative range of life-permitting values for the parameters of physics along with the principle of indifference, a commonly used principle of probabilistic reasoning. (See section III above). *Thus, I*

conclude, the core argument for preferring theism over the atheistic single-universe hypothesis is much stronger than the probabilistic version of the atheist argument from evil.

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2. It should be noted here that just because some physical quantity is fine-tuned, it does not follow that every function of that quantity will be fine-tuned. So, for instance, if the strength S of the strong nuclear force is fine-tuned, there will always exist an infinite number of functions F(S) of this force strength that are not fine-tuned This issue will be illustrated and explained when we discuss probability in section III, subsection ii-c. For now, we simply note that when we talk about the fine-tuning, we are always referring the fine-tuning of the parameters that are actually considered in physics (particularly those that directly correspond to physical quantities), not arbitrary functions of those parameters.

3. For those familiar with the probability calculus, a precise statement of the degree to which evidence counts in favor of one hypothesis over another can be given in terms of the odds form of Bayes's Theorem: that is, $P(H_1/E)/P(H_2/E) = [P(H_1)/P(H_2)] \times [P(E/H_1)/P(E/H_2)]$. The general version of the principle stated here, however, does not require the applicability or truth of Bayes's theorem. (It also should be noted that the Baysian version of the principle requires that $P(H_1)$ and $P(H_2)$ are non-zero in order for confirmation to occur.)

4. A more precise, and technical, version of premise (1) and (2) is presented below. Moreover, below we will argue that the existence of life-permitting cosmic conditions under theism is actually probable--that is, it has a probability greater than or equal to 0.5. This means that the existence of life-permitting cosmic conditions *strongly* confirms theism over the atheistic single-universe hypothesis, instead of merely *significantly* confirming theism as stated in the present conclusion.

5. Premise (2) could also be defined in terms of the *classical conception of probability* which defines probability in terms of the ratio of number of "favorable cases" to the total number of equipossible cases. (Weatherford, chapter 2; also see section III-iia below for a definition of equipossible) Thus, for instance, under this conception, to say the probability of a die coming up "4" is 1/6 is simply to say that the number of ways a die could come up "4" is 1/6 the number of equipossible ways it could come up. Extending the this definition to the continuous case, classical probability can be defined in terms of the relevant ratio of ranges, areas, or volumes over which the principle of indifference applies. (See section III-iic below.) *Thus, under this extended definition, to say that the probability of the parameters of physics falling into the life-permitting value is very improbable simply means that the ratio of life-permitting values to the range of possible values is very, very small.* (As section III-iic explains, however, this definition only works for those cases in which the parameters directly correspond to a physical magnitude, and there is no other parameter that corresponds to a physical magnitude that yields a conflicting probability distribution.)

6. For an in-depth discussion of epistemic probability, see Keynes (1921), Swinburne (1973), Hacking, (1975), and Plantinga (1993), chapters 8 and 9.

7. Alvin Plantinga (1993, p. 168) presents one possible counterfactual way of explicating what is meant here by the "degree to which a proposition S *of itself* should rationally lead us to expect that R is true." Although I do not agree that his the best way, his account does show that it is possible to coherently further explicate this notion.

8. Strictly speaking, premise (1) could either be translated as P(Lpc/T & Ft) or as P(Lpc/T) *relative to the background information that the universe is fine-tuned*, and these two need not be the same: the former is the degree to which T & Ft of itself should lead us to expect Lpc, whereas the latter is the degree to which T of itself should lead us to expect Lpc given that we believe Ft. We shall, however, always interpret premise (1) as stating the former, and correspondingly for premise (2).

9. Note that this precise version of premise (1) is meant to exclude the possibility that the existence of life-permitting cosmic conditions qualify as *not highly improbable* under theism simply because it has no probability, or range of probability, at all under theism. It is unclear, however, whether exclusion is needed for the our main argument to apply: that is, the prime principle of confirmation, or some plausible variant of it, might even apply when the evidence is highly improbable under hypothesis H_1, but has no probability or range of probability under H_2. We will not discuss this issue here, however, since the whole discussion is preempted by our argument below that the existence of a universe with life-permitting cosmic conditions is actually probable under theism.

Finally, note that the above formulation implicitly assumes that there is only one universe--e.g., Lpc refers to the claim that *the* universe has life-permitting cosmic conditions, and thus implicitly assumes a single universe. This makes no difference in our argument as long as we restrict ourselves to the theistic single-universe hypothesis and the atheistic single-universe hypothesis, and the relations of confirmation between them. If we also want to argue that the theistic many-universes hypothesis is confirmed relative to the atheistic single-universe hypothesis, however, then it's best to let Ft represent the claim that *some* universe is fine-tuned, and Lpc the claim that *some* universe that is fine-tuned has life-permitting cosmic conditions. Clearly, premise (2) remains unaffected with these new definitions since the atheistic single universe-hypothesis presupposes a single universe, and thus the claim that *some* universe has a particular property becomes equivalent to the claim that the *actual* universe has that property. Moreover, premise (1) still seems to be true: if God has created some set of fine-tuned universes, it does not seem highly improbable that God would arrange things so that one member of that set would be life-permitting. (Moreover, with minor modifications, the same argument offered below for the strong version of premise (1) discussed below in which P(Lpc/T & Ft) >= 0.5 works for these alternative definitions of Lpc and Ft.) Accordingly, the core version of the argument seems to work as well for these alternative definitions of Ft and Lpc as those in the main text. I did not use them in the main text, however, because it makes the wording awkward at various points.

10. One might object to this argument by claiming that because of the existence of evil, we do not know that the existence of embodied, conscious, intelligent beings is a good thing as the argument seems to assume. To address this objection, let E' represent the claim that embodied conscious beings exist in the universe *and* that their embodied existence is a positive good (that is, something that increases the overall value of reality). Then, it follows from the above argument that claim E' is not highly improbable under theism. But, E' entails the claim E that embodied, conscious beings exist, and we know that for all types of probability, if one claim R entails another claim S, then the probability of S is greater than or equal to that of R. Hence, if E' is not highly improbable under theism, then it follows that E isn't either.

11. For the alternative definitions of Lpc and Ft mentioned in a footnote above--that is, those definitions that referred to *some* universe instead of *the* universe--we need to define E' as the claim that *some* universe that is fine-tuned has conscious, embodied beings whose overall existence is good, and then we need to include the alternative definition of Ft as part of our background information.

12. To see the justification for this last move, we simply note that if T of itself should lead us to expect Lpc--that is, if P(Lpc/T) >= 0.5--then T & Ft of itself should also lead us to expect Lpc, since Ft neither undercuts our reasons for thinking God would bring about a universe with conscious embodied beings nor is it evidence of itself that Lpc has not occurred. If one is still not convinced that this last move is legitimate, then one could use *P(Lpc/T) relative to background information Ft* for premise (1) instead of P(Lpc/T & Ft), and correspondingly for premise (2). All the arguments would go through as well for this replacement, but the wording in the main text would become more awkward.

13. Other versions of the principle of indifference have been given in the literature. I believe, however, that this is the best version.

14. This consideration of the "illuminated range" requires that the probabilities in premise (1) and premise (2) of our main argument must be conditioned on the information that the parameters of physics are within the illuminated range. That is, if we let IL denote the proposition that the parameters of physics are in the

illuminated range, then premise (1) becomes *P(Lpc/T & FT & IL)* > Q, and premise (2) becomes *P(Lpc/As & FT & IL)* < Q. In the case of G , calculations indicate that the conditional probability of G falling within the life-permitting range would be less than $1/10^{40}$ since this range is less than $1/10^{40}$ of the range 0 to $2G_0$, the latter range being certainly smaller than the total "illuminated" range for G. Thus, $Q = 1/10^{40}$ in this case.

15. I say "approximately right" because in this case the principle of indifference only applies to strips of land that are the same distance from the equator. The reason for this is that only strips of land equi-distance from the equator are truly symmetrical with regard to the motion of the earth. Since the northern, contiguous United States is all about the same distance from the equator, equal land areas should be assigned approximately equal probabilities.

16. This solution will not always work since, as the well-known Bertrand Paradoxes illustrate (e.g., see Weatherford, p. 56), sometimes there are two equally good and conflicting parameters that directly correspond to a physical quantity and to which the principle of indifference applies. In these cases, at best we can say that the probability is somewhere between that given by the two conflicting parameters. This problem, however, typically does not seem to arise for most cases of fine-tuning. Also, it should be noted that the principle of indifference applies best to *classical* or *epistemic* probability. (See section II above.)

17. In the case of premise (2), we also said that it could be explicated in terms of *classical* probability. (See section II above.) Since the definition of classical probability is in terms of equipossible cases , or ratios of ranges for the continuous case, it should be obvious that the principle of indifference applies to classical probability.

18. Two notes. i) With minor modifications to the above argument can be used to derive a corresponding principle of indifference for conditional epistemic probability. ii) As mentioned above, to derive the principle of indifference for the continuous case, we also must assume that the size of the range (but not the magnitude of values covered by the range) is epistemically relevant under the *natural measure*--that is, for those cases in which the parameter directly corresponds to a physical quantity. The full justification for this claim begins by noting that a proposition R is epistemically relevant to S if and only if a well-informed rational person in the circumstances in question would take R as evidence for or against S (and taking it as relevant coheres with our other epistemic practices.) Thus, both the fact that the size of a range under the natural measure strikes us as epistemically relevant in the case of the fine-tuning, and the fact that it is typically taken as epistemically relevant in other non-fine-tuning cases, is very strong evidence that it is relevant, given that this practice coheres with our other epistemic practices. In a unpublished manuscript in progress, I argue that the size of a range (but not the magnitude of values covered by a range) is indeed typically taken as being epistemically relevant, and that this not only coheres with our other epistemic practices, but is central to some of them, such as the fact that more precise predictions are considered to confirm a theory more than less precise predictions. (The notion of predictive precision requires the assumption of a natural measure.)

19. Of course, one could claim that our experience with items such as coins and dies teaches us that whenever two alternatives are macroscopically symmetrical, we should assign them an equal probability, unless we have a particular reason not to. All this claim implies, however, is that we have experiential justification for the principle of indifference, and thus it does not take away from our main point that in certain practical situations we must rely on the principle of indifference to justify our assignment of probability.

20. Remember, the odds form of Bayes's theorem states that $P(H_1/E)/P(H_2/E) = [P(H_1)/P(H_2)] \times [P(E/H_1)/P(E/H_2)]$.

21. As discussed in section II, the kind of probability invoked here is what philosophers call *epistemic probability*, which as we defined above is a measure of the rational degree of belief we should have in a proposition. Since our rational degree of belief in a necessary truth can be less than 1, we can sensibly

speak of it being improbable for a given law of nature to exist necessarily. For example, we can speak of an unproven mathematical hypotheses--such as Goldbach's conjecture that every even number greater than 6 is the sum of two odd primes--as being probably true or probably false given our current evidence, even though all mathematical hypotheses are either necessarily true or necessarily false.

22. Because the total area of the dart board would be infinite, and one cannot meaningfully take ratios of infinite quantities, this idea of the total non-bull's-eye region being exceedingly larger, of course, would have to be spelled out in terms of a limit as one takes larger and larger regions of the dart board. It's doubtful, however, that one can even make sense of the relative size of regions on this dart board (since in general there is no natural way of parameterizing the laws of physics) , but that is really a problem for those raising the MLP objection.

23. I define a "universe" as any region of space-time that is disconnected from other regions in such a way that the parameters of physics in that region could differ significantly from the other regions.

24. Moreover, the advocate of the atheistic many-universes hypothesis could not avoid this problem by hypothesizing that the many-universes always existed as a "brute fact" without being produced by a universe generator. This would simply add to the problem: it would not only leave unexplained the existence of life-permitting cosmic conditions in our own universe, but would leave unexplained the existence of these other universes.

25. This connection between order and probability, and the second law of thermodynamics in general, is given a precise formulation in a branch of fundamental physics called *statistical mechanics*. Typically in statistical mechanics a state of high macroscopic order corresponds to a very improbable state, and a state of high macroscopic disorder represents a highly probable state.

26. A more thorough discussion of the atheist argument from evil is presented in chapter ?? and a discussion of other atheistic arguments is given in chapter ??.