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PROBLEMS WITH THE ARGUMENT FROM FINE TUNING

ABSTRACT. The argument from fine tuning is supposed to establish the existence of God from the fact that the evolution of carbon-based life requires the laws of physics and the boundary conditions of the universe to be more or less as they are. We demonstrate that this argument fails. In particular, we focus on problems associated with the role probabilities play in the argument. We show that, even granting the fine tuning of the universe, it does not follow that the universe is improbable, thus no explanation of the fine tuning, theistic or otherwise, is required.

1. INTRODUCTION

There has been a great deal of recent interest from both physicists and philosophers in the so-called fine-tuning argument.[1] This is the argument that purports to deliver the conclusion that God exists from the fact that our universe seems remarkably fine tuned for the emergence of carbon-based life. In this paper we discuss several difficulties with this argument. Central to these concerns are the fact that the argument rides roughshod over crucial matters concerning probability.

Before we move to our objections it will be convenient to state the fine-tuning argument with some degree of precision.[2]

(1) The boundary conditions and laws of physics could not have been too different from the way they actually are if the Universe is to contain (carbon-based) life.
(2) The Universe does contain (carbon-based) life.

Hence:

(3) The Universe as we find it is improbable.
(4) The best explanation for this improbable fact is that the Universe was created by some intelligence.

Hence:

(5) A Universe-creating intelligence exists.

First, let us say a few words about the above presentation of the argument. Our presentation is a little more careful than those one usually encounters.

Synthese (2005) 145: 325–338 © Springer 2005

There are two reasons for this. On the one hand, some versions of the argument are so vague that it is hard to take them seriously at all and we wish to focus on the strongest and most compelling version of the argument; and this, we believe, we have presented above. On the other hand, we believe that it is the lack of precision in many of the presentations that has allowed the argument to survive so long. Once the various premises and inferences are made explicit the shortcomings of the argument are plain to see. We have not set up a straw person though. The above presentation is true to the spirit of the argument as presented by its most influential advocates Leslie (1989, 1998) and Swinburne (1990, 1991).[3]

Next, let us say a few words about the fine tuning mentioned in the argument. Although there are many fascinating examples of the fine tuning in question,[4] of particular interest are the rather narrow ranges in which certain physical constants must fall if (carbon-based) life is to be possible. For example, for elements as complex as carbon to be stable, the electron–proton mass ration ($m_e \cong 5.44617013 \times 10^{-4}$) and the fine structure constant ($\alpha \cong 7.2973530810^{-3}$) could not have been more than a few percent from their actual values.

A great deal has been written on this evidence and even more on the issue of what the best explanation for this fine tuning is: God or multiple universes.[5] We will have little to say about either of these debates. We will not question the scientific evidence for fine tuning. (That is, we grant premise (1) of the above argument.) Instead, we examine other aspects of the argument that deserve closer attention than they have thus far received. In particular, we focus on the argument from (1) and (2) to (3). We show that none of the fanciful explanations for fine tuning is required, because (3) simply does not follow from (1) and (2).

2. THE IMPROBABILITY OF FINE TUNING

Consider the inference from (1) and (2) to (3). The first thing to notice here is that the argument presupposes that the laws of physics or the boundary conditions of the universe could have been other than they are. After all, if they *could not* have been different, the probability of the universe being just as we find it is 1, and no fine tuning has occurred. But what is the modality invoked here? Logical possibility? Conceptual possibility? Physical possibility? This is rarely spelled out in the usual presentations of the argument. One exception is Leslie, who explicitly invokes *logical* possibility (1989, p. 15) and so we will initially follow him on this.[6] It certainly *is* logically possible that various physical constants, for instance, could take any real number as their value. Logical possibility, then, seems a promising option.

The central idea of the fine-tuning argument is that some physical constant, k say, must take a value in some very narrow range in order for (carbon-based) life to evolve.[7] Let us suppose that the constant in question has to lie between the values $\nu - \delta$ and $\nu + \epsilon$. (Where ν is the actual value of k and δ and ϵ are small, positive real numbers.) The intuitive idea is that the interval $[\nu - \delta, \nu + \epsilon]$ is very small compared to all the logically possible values k might have taken (i.e., the whole real line), and since there is no explanation of why $k = \nu$ and not any other value, all possible values of k should be considered equally likely. Thus, the probability of k taking a value in $[\nu - \delta, \nu + \epsilon]$ is also very small. That's the intuitive idea, but the problem is that it's not at all clear how this naïve intuition can be made rigorous.

One way to try to cash out this intuition is to compare the number of values that k can take in $[\nu - \delta, \nu + \epsilon]$ to the all possible values it could take in the real line. But in each case there are $2^{\aleph_0}$ values so the relevant probability would appear to be one.[8] That, however, is misguided. We are not interested in the *number* of values k could take but rather the *measure* of the sets in question.[9] Employing any standard measure (such as Lebesgue measure) will, as the fine tuning argument proponent suggests, indeed yield a very low probability for $k \in [\nu - \delta, \nu + \epsilon]$. The problem for the proponent of the fine tuning argument, however is that the probability is too low! Such measures will yield a finite value for the interval $[\nu - \delta, \nu + \epsilon]$ and an infinite value for the whole real line. The resulting probability for $k \in [\nu - \delta, \nu + \epsilon]$ is zero (or infinitesimal if you prefer a non-standard analysis take on this).[10] What is more, the probability that k takes a value in any finite interval will be the same – even those we intuitively think of as being extremely large. So, for example, the probability of $k \in [\nu - 10^{10^{10}}, \nu + 10^{10^{10}}]$ is also zero (or infinitesimal).[11]

The fine tuning argument, on its most plausible interpretation, hence not only shows that life-permitting universes are improbable, but, arguably, that they are *impossible*! Surely something has gone wrong. Admittedly, the problem here has nothing to do with the fine-tuning argument; it concerns (standard) probability theory. Indeed, similar reasoning shows that an infinitely sharp dart cannot hit a dart board, no matter how big the board is; or that no one can win a lottery that has infinitely many tickets. It's true that such paradoxes of probability theory are well known and that there does not seem to be any consensus on how they are to be resolved. This does not, however, relieve the defender of the fine-tuning argument of the burden of proof. Anyone advancing this argument must demonstrate that the probability that the physical constants take life-supporting values is low, or the argument – whatever its other merits or difficulties – does not even get off the ground. If the only argument to show that the probability that the physical constants take values that permit carbon-based life is *low* also shows that it is *impossible* for them to take those values, that argument must be rejected and we are back to square one, without any reason to believe that there is any phenomenon needing explanation, least of all, explanation by an intelligent deity.

Now someone might be tempted to accept that the probability of the universe as we find it is zero, but deny that events with zero probability are impossible. This, however, will not help, for the objection can be recast without appeal to assumptions about how we should interpret zero probabilities. First, we reiterate our point above that the probability of finding the constant in question in any finite interval is zero. This makes a mockery of the claim that *the class of life-permitting universes, in particular*, is improbable. The defender of the fine-tuning argument is now obliged to tell us why this class of universes is more improbable than others.[12] Accepting that this class of universes has probability zero but that this does not render it impossible does nothing to defuse the problem at hand. Second, there are other problems looming for anyone prepared to bite the bullet and accept that the probability that we find ourselves in this class of universes is zero. Accepting that the universe as we find it has probability zero means that the conditional probability of any hypothesis relative to the fine-tuning data is undefined. This makes the next move in the argument from fine tuning – that the hypothesis of an intelligent designer is more likely than not, given the fine-tuning data – untenable. Moreover, even if you focus, using a Bayesian hypothesis testing model of inference, on the inverse probability (the probability of the evidence, given the hypothesis), then on this assumption, no hypothesis is capable of raising the probability of a fine-tuned universe – if the probability is zero, it stays at zero (using standard updating procedures like Bayes' Rule).[13] For now, we wish to simply point out that on any standard calculation of the probability of a fine-tuned universe, the probability of that universe comes out as zero – *and therein lies the problem*. The defender of the fine-tuning argument must find another way to show how the intuition that $[\nu - \delta, \nu + \epsilon]$ is small can be made to support the claim that the probability of $k \in [\nu - \delta, \nu + \epsilon]$ is low (but not zero).

One plausible way out of this problem is to retreat from logical possibility and restrict the range of values that k can take from all of the reals to something more manageable. The move, in essence, is to reject logical possibility, which cannot discount any real values, and adopt a weaker notion of possibility that allows a smaller range of values. Conceptual possibility? That can't be right though, because it also seems to be conceptually possible that the physical constants could take any real number as their value. Physical possibility (construed as consistency with the laws of physics and physical constants as we find them) however, restricts the range *too* much for the proponent of the fine tuning argument, leaving the *actual* values as the only *possible* ones, and hence setting the probability at 1! The trick is to find some set of possible values that k could take that is large enough for $[\nu - \delta, \nu + \epsilon]$ to seem small, but small enough for the resulting probability for $k \in [\nu - \delta, \nu + \epsilon]$ to be non-zero. (That is, for the class in question to have a large but finite measure.) Putting it this way, however, illustrates how arbitrary this restriction is going to be. It's not going to be any obvious, naturally-occurring, sense of possibility (such as logical, conceptual or physical possibility). The class in question has to be hand picked: choose something too small ($[\nu - \delta, \nu + \epsilon]$, say) and the probability of $k \in [\nu - \delta, \nu + \epsilon]$ is too large; choose something too large and the probability of $k \in [\nu - \delta, \nu + \epsilon]$ is zero. Indeed, it seems that the choice of the class in question needs to be fine tuned!

Leslie does seem to endorse such a move (for reasons not unrelated to the problems we have raised), despite explicitly invoking logical possibility as the appropriate modality:

> Imagine that a bullet hits a fly surrounded by a large empty area. The bullet's trajectory needed fine tuning to achieve this result, which can help to show that a marksman was at work. It can help to show it regardless of whether distant areas are all of them so covered with flies that any bullet striking them would hit one. The crucial point is that the local area contained just one fly. (Leslie 1998)

Leslie does not think that there is anything problematic about the appeal to "local area" here but he is clearly wrong about this. As we have already argued, this "local area" needs to be specified in a non-arbitrary way and it needs to be the right size to get the probability of $k \in [\nu - \delta, \nu + \epsilon]$ right for the fine-tuning argument to work. There is a significant task here for Leslie and other defenders of this version of the fine tuning argument: they must come clean about the specification of the "local area". We do not see how this can be done in a non-question-begging way. In the absence of such a specification, we conclude that there is no argument from (1) and (2) to (3) and the argument as a whole fails.

We should point out that there may be a solution to this problem, for at least some of the constants in question. It might be that the laws of physics themselves set limits on the values certain constants can take. The idea is that the laws of physics specify some probability distribution (not necessarily uniform) over the possible values a constant can take, such that any interval wholly outside a certain range will have probability zero but there will be a non-zero probability for any interval (at least partially) within the range in question.[14] Now if the range of values that yield inhabitable universes is such that the probability distribution in question assigns a small probability to this interval, the fine-tuning argument may yet be made to fly.[15] So let us say a something about this version of the argument. The first thing to say is that it is not clear that we can distinguish between the nomic character of that part of physics we can abstract from the values of the constants themselves and that of the values the constants take. If we can't, this proposal collapses. Second, it is at least arbitrary to choose this restricted interval if the abilities of a deity are in question: Why couldn't the deity have changed the laws of physics and so altered the interval? (Or if you prefer the multiple universes explanation, why should we posit only universes with the same laws of physics; why not universes with different laws?) Third, this version of the argument presupposes that the probability of finding the values of the constant in question in $[\nu - \delta, \nu + \epsilon]$ is low simply because $[\nu - \delta, \nu + \epsilon]$ is small compared to some larger interval of possible values. But this is only the case if we are presupposing a uniform distribution or some other distribution that has little probability density over $[\nu - \delta, \nu + \epsilon]$. Without some independent argument for the shape of the distribution in question, this version of the argument simply begs the question. Indeed, in the absence of any knowledge about the shape of the distribution, surely the fine tuning of this universe is at least as good an argument for a probability distribution that has most of the density over the interval $[\nu - \delta, \nu + \epsilon]$ as it is for a universe with an intelligent designer.

But let us suppose that the relevant physics delivers not only the range that the constant in question can take, but also the probability distribution over that interval.[16] Let us further suppose that according to the distribution delivered, the probability of the constant falling in the life-permitting range, $[\nu - \delta, \nu + \epsilon]$, is very small. Would this be enough for the fine-tuning argument to work? Not quite. The first two of the problems we raised above still stand. But here we also need to ask some questions about the laws of physics. Arguably, part of the job of the laws of physics is to provide explanations. What we have here, though, is a case of the laws of physics rendering certain evidence (the fine tuning) utterly improbable. Of course, that is precisely what the defender of the fine-tuning argument wants, for the next item on their agenda is to introduce some further hypothesis that explains (or at least raises the probability) of the evidence. But the fact remains that the improbability of the evidence according to the laws in question should raise doubts about the laws themselves or the probability distribution delivered by the laws. We are not suggestion that we ought to abandon, say, quantum mechanics in the light of an example of fine tuning that is rendered improbable by quantum mechanics. Rather, we are suggestion that the derivation of the probability distribution in question should be questioned in such a case. After all, if there is any uncertainty about the shape of the probability distribution (as surely there must be), then it seems rather natural to suggest that the evidence (the fine-tuning) supports the hypothesis that the given distribution should be rejected for one that has greater density over the life-permitting interval $[\nu - \delta, \nu + \epsilon]$. Still, this version of the fine-tuning argument strikes us as a better candidate than the standard ones to be found in the philosophical literature to date.

3. HAVE WE PROVEN TOO MUCH?

There is a rather interesting objection to our argument. If what we say above is correct – that the probability of k falling in *any* finite interval has probability zero (if the relevant reference class is all the real numbers) – then it might seem as though we have proved too much. After all, surely there is *some evidence* that would count as evidence for a designer – the words "made by God" carved in English on the surface of all the planets, or a great voice from the sky proclaiming God as the author and explaining in detail just how s/he did it all. But, by arguments, similar to ours above, it can be shown that any such evidence has probability zero and hence, no design argument can be mounted based on it. Our argument of Section 2 is thus too strong to be plausible, or so this line of objection goes.

First, notice that this objection to our argument does not establish the cogency of the fine-tuning argument. At best, it casts doubt on our claim that the probabilities in question are zero. So let's not get confused about the force of this reply. Next, note that this is really just the "problems with probability theory" objection over again. (Recall, this is the objection that the problem we raised in the first part of Section 2 is a problem for classical probability theory and not specifically a problem for the fine-tuning argument.) What lies at the heart of this objection is the fact that standard probability theory gives probabilities of zero when *any set* with finite measure is considered in relation to reference classes with infinite measure. So, as we have already pointed out, even intuitively large intervals such as $[\nu - 10^{10^{10}}, \nu + 10^{10^{10}}]$ have zero probability assigned to them. And this is why this objection not only fails to give aid and comfort to the fine tuning argument per se, but also why it does not undermine the soundness of our objections to the argument. As we have noted above, the proponent of the fine-tuning arguments is the one invoking probability theory here to get us from data to deity. It is the proponent's responsibility to make that probabilistic argument cogent. Invoking probability theory, presumably to make the fine tuning argument more rigourous, but then pointing out that probability theory is of little use in this case is self-defeating. The burden of proof here is fairly and squarely on the defender of the fine tuning argument. To reply that our critique of the probability calculations is too strong, *even if correct*, amounts to giving up the game.

But some may not be satisfied with this burden-of-proof reply. So let us tackle the "proves too much" charge more directly. First, if the above argument were to show that all design arguments are flawed because of botched probabilistic reasoning, then at least one of the present authors would be inclined to say "so be it". Design arguments, he would say, are all bad, even prima facie good ones.[18] However, we concede, that that's not what we have shown. We argued that the relevant sense of possibility cannot be *logical possibility* and the relevant reference class cannot be the class of real numbers. We have suggested, however, one way in which the fine tuning argument can be made to work: use physical possibility and show that the laws of physics put bounds on the possible ranges of the physical constants; and give probability distributions which have very little density over the life-supporting interval $[\nu-\delta, \nu+\epsilon]$. This might even give low, but non-zero probabilities for "made by God" tags and big voices from the sky, and we could then imagine successful design arguments – arguments that would rely on the demonstration that events with these very low, but non-zero probabilities occur, and that they are far more probable on the design hypothesis than on the null hypothesis. This, admittedly, is a tall order. Be that as it may, but we are *not* suggesting that *no* evidence will count for an intelligent designer, just that the evidence needs to be much more compelling than that with which we have been presented to date.[19]

4. THE RETREAT FROM PROBABILITY

Given the serious problems facing a rigourous probability argument for the move from (1) and (2) to (3), some supporters of the fine-tuning argument are tempted with a retreat from probability talk. The first option is to simply invoke "ball park" probabilities; the second, more-radical option is to abandon probabilities altogether.

Consider the first option. All the supporter of the intelligent designer requires, one might say, is that the probability of a designer, given the fine-tuning evidence, is greater than the probability of the negation of this hypothesis, given the same fine-tuning evidence. There is no need to embark on precise estimates of the probabilities in question and hence the difficulties we outlined can be avoided. Or so it is claimed. But there are serious difficulties for this version of the argument as well.

This version of the argument relies on showing that

(FT1) $\Pr(D/E) > \Pr(\neg D/E)$,

where D is the design hypothesis and E is the fine tuning evidence. Now using the inverse probability law from elementary probability theory we can rewrite (FT1) as (assuming, of course, that $\Pr(E)$ is not zero):

(FT2) $\Pr(E/D).\Pr(D)/\Pr(E) > \Pr(E/\neg D).\Pr(\neg D)/\Pr(E)$.

And to show that this holds, it suffices to show that:

(FT3) $\Pr(E/D).\Pr(D) > \Pr(E/\neg D).\Pr(\neg D)$.

But notice that employing (FT1) as a premise in the argument, without independent argument for the probabilities in question, is question begging. In order to get something useful for the proponent of the argument, the inverse probability law needs to be invoked. But the inverse probability law can only be used if $\Pr(E)$ is not zero. But in Section 2 we showed that zero is precisely the value of $\Pr(E)$ we obtain from any standard presentation of the argument.[20] It hence seems that the problems we raised for the rigourous presentation of the argument cannot be avoided by considering only inequalities.

Finally, it has been suggested that we ought to abandon probability talk altogether and present the argument along the following lines:

(5) The boundary conditions and laws of physics could not have been too different from the way they actually are if the Universe is to contain (carbon-based) life.
(6) The Universe does contain (carbon-based) life.

Hence:

(7) The Universe as we find it requires explanation.
(8) The best explanation for the Universe as we find it is that it was created by some intelligence.

There are many problems with such a presentation. First, and foremost, it does not avoid the problems we raised; it simply *glosses over* them. After all, why believe (7)? Presumably, because such a universe is thought to be improbable. But we have shown that this has not been established. We won't pursue the shortcomings of this argument here though. For such an argument is a long way removed from our original target of probabilistic versions of the argument from fine tuning (as defended by Leslie and others). In essence, a retreat to a non-probabilistic version of the argument is to give up the (current) game.

5. CONCLUSION

The argument from fine-tuning is the most recent and most popular variety of design argument. As a design argument, it has an illustrious history. Variations are to be found in Aquinas, the 18th century, the 19th century, and again more recently. In each epoch, what it is about the cosmos that is supposed to warrant the design hypothesis has been different: the mechanistic solar system, biological organs, and now: fine tuning. But the fundamental flaws in the design argument really have nothing to do with the particular suspect chosen.[21] We have shown that the fine-tuning version of the argument is no better than its predecessors: the argument from fine tuning fails because of fallacious probabilistic reasoning.

ACKNOWLEDGEMENTS

We'd like to thank Ernie Aleva, Nalini Bhushan, Charlie Donahue, Phil Dowe, Peter Forrest, Alan Hájek, Chris Hitchcock, Steve Horst, Murray Kiteley, Al Mosley, Graham Oppy, Joe O'Rourke, Jeff Ramsey, Ngawang Samten, Elliott Sober, Neil Thomason, Graham Wood, and Brian Woodcock for comments and discussion. We are especially grateful to Bruce Langtry, whose thoughtful and detailed criticisms of an earlier version of this paper led to substantial revisions and many improvements. Earlier versions of this paper were presented to the Department of Philosophy at the University of California, Santa Barbara, the Department of Philosophy at the University of North Carolina, Chapel Hill, the Department of Philosophy at the University of Western Australia, the Department of Philosophy at Smith College, the 2001 Australasian Association of Philosophy Conference in Hobast, Tasmania, and a Foundations of Science Workshop at the Federal University of Santa Catarina in Florianópolis, Brazil. We are grateful to the audiences at all these presentations for some very lively discussions. Finally, we'd like to thank two anonymous referees of this journal for many helpful suggestions.

NOTES

[1] See, for example, Polkinghorne (1986), Davies (1992, Chap. 8), Hawking (1988, Chap. 8), Leslie (1990), Barrow and Tipler (1986), Dembski (1999) and Smart (1989, Chap. 7).

[2] In what follows we rely heavily on the influential presentations of the argument by Leslie (1989, 1998) and Swinburne (1990, 1991) as well as on Dowe's (to appear) somewhat more careful presentation.

3 Some such as Leslie, often prefer to present the argument in analogical terms, without the trappings of probability theory. Although we think that such presentations lack force, most of what we have to say in this paper is directed at versions of the argument that employ probability theory. As we shall see, we do think that there is a stronger version of the argument to be had. But this stronger version is best seen in light of the shortcomings of the version we present here.

4 See Barrow and Tipler (1986) and Rees (1999) for details. Not everyone, however, is convinced that the universe is fine tuned. See, for example, Weinberg (1993, pp. 201–203) for scepticism in this regard.

5 See Leslie (1989), Hacking (1987), Dowe (to appear) and White (2000), as well as many of the essays in Leslie (1990).

6 We will discuss the other modalities – physical and conceptual possibility – shortly.

7 Of course, there are many such constants but the higher-dimensional case is essentially no different from the one-dimensional case. Thus, without loss of generality, we can restrict out attention to the single dimensional case.

8 Leslie, for one, considers this issue without resolving it in any rigorous manner (1989, pp. 198–203).

9 See, Halmos (1974), for an introduction to measure theory.

10 Paul Davies (1992, pp. 204–205) recognises this problem but oddly enough, he provides no solution (indeed, he admits that he knows of no solution) and yet he seems content to accept the claim that fine tuning is in need of explanation. In effect, he admits the failure of the inference from (1) and (2) to (3) but (inexplicably) thinks that this does not matter. Moreover, he offers no account of why this does not matter. McGrew et al. (2001) also criticise the fine-tuning argument in this regard. Indeed, many of the points we make in the first part of this section were made independently by McGrew et al. (2001).

11 This serves to highlight the fact that our intuition that $[\nu - \delta, \nu + \epsilon]$ is small is driven by conventions about measuring scales. After all, if $[\nu - \delta, \nu + \epsilon]$ seems small on some measuring scale, it can be made to seem arbitrarily large by applying a suitable, positive, linear transformation. The relevant laws are invariant under such transformations and so measuring scales (and intuitions about smallness) are purely conventional. We thus see that even the intuition that $[\nu - \delta, \nu + \epsilon]$ is small is highly questionable.

12 Of course the defender of the fine-tuning argument can show that if the probability of the class of fine tuned universes is zero, then this probability is less than the probability of the complement of this class (the class of all the non-fine-tuned universes). If the probability of the former is zero, the probability of the latter is one. But there are other problems in store for such probability assignments when we arrive at the next stage of the argument when conditional probabilities are required. But our point here is simply that the probability of finding the constant in any finite interval is zero – there's nothing special about the life-permitting range.

13 See Priest (1981) for more on related problems with the conditional probabilities employed in design arguments.

14 That is, the laws of physics prescribe a probability distribution with compact support for the value of the constant in question.

15 We are indebted to Phil Dowe for this suggestion.

16 An argument along these lines has been discussed by Rubakov and Shaposhnikov (1989) and Shaposhnikov and Tkachev (1990).

[17] Much of this section is a reply to a very probing set of objections by Bruce Langtry.

[18] We should point out that there's nothing necessarily anti-theistic in such a remark. Indeed, we would have some good theists as company here. Many theists, too, think that there can be no evidence for the existence of God – such belief, they claim, must be motivated by faith, not evidence (or at least not evidence of the kind under consideration here).

[19] Alternatively, the defender of the fine-tuning argument might explore other measures on the sets in question: measures that give the life-permitting class of universes low but non-zero probability. Of course such measures exist, but they will need to be independently motivated. The latter is the difficult part and we see no non-question-begging way to go about it. We thank Brian Woodcock for this suggestion.

[20] At this point someone might appeal to non-standard probability theories (e.g., Goosens 1979) to save the fine-tuning argument, and, it must be said, save probability theory from some rather unintuitive results elsewhere. To our knowledge, no one has made such a case in the context of the fine-tuning argument. To advance such a case and assess its likely success is beyond the scope of this paper. For now we simply leave such a non-classical approach to the fine tuning argument as a live option (though, for the record, we do not hold much hope for it).

[21] And the problems with design arguments are serious. Many of these problems were pointed out long ago by Hume (1955). See also Sober (forthcoming) and Priest (1981). And many of these problems are also problems for the fine-tuning version of the argument. For example, the latter presupposes that it's carbon-based life that's important. But why not the emergence of television or the game show Wheel of Fortune? Presumably, the range of constants required for the immergence of Wheel of Fortune would be at least as small as the interval permitting carbon-based life. Thus, an argument for a game-show loving God seems to be in the offing. Also, the issue of the kind of designer is completely unspecified by the argument. Or perhaps, given the prevalence of cold, dark empty space in the universe and the sorry fate of life as the universe cools we should posit a God who loves frozen voids and the slow torture of the living. Moreover, the Fine Tuning argument leaves the choice of a tuner wide open. While a Christian God is the usual suspect of those who advance the argument in the recent literature, there are so many possible deities that any specific theological conclusions would be hazardous even if the remainder of the argument were cogent.

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