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PRIOR PROBABILITIES IN THE ARGUMENT FROM FINE-TUNING

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Theism is a far simpler hypothesis, and so a priori more probably true, than naturalism, understood as the hypothesis that the existence of this law-governed universe has no explanation. Theism postulates only one entity (God) with very simple properties, whereas naturalism has to postulate either innumerable entities all having the same properties, or one very complicated entity with the power to produce the former. If theism is true, it is moderately probable that God would create humanoid beings and so humanoid bodies; but laws of nature would have to have very special properties if they are to bring about the existencne of humaoid bodies. Given laws of the present form (quantum theory with the Pauli principle and the four forces), the constants of the laws and variables of the boundary conditions of the universe would need to be extremely fine-tuned; and no simpler set of laws would allow the existence of humanoid bodies at all. So the evidence of the existence of humanoid bodies adds further to the probability of theism as against naturalism.

The worth of the argument from fine-tuning is a central issue in this conference, and we should by now be familiar with its form. But let me set it out in my own way. I define a universe as tuned if it is hospitable to humanoid bodies. By a humanoid I understand an embodied being sufficiently like ourselves in having an enormous variety of largely true beliefs about the state of the world and each other in important respects; and desires (and so purposes to which they may give rise) to produce many different good and evil effects on themselves, each other and the world. By the being being embodied I mean that it acquires its beliefs and desires and executes its purposes through a public object — its body. To do this job, a humanoid body will need: (1) sense-organs with an enormous variety of possible states varying with an enormous variety of different inputs caused by different distant world-states. (2) an information processor which can turn the states of sense-organs into brain states which give rise to beliefs of whatever kind currently interests the humanoid. (We need to sort out the incoming information into correlates of beliefs of moral or prudential importance.) (3) a memory bank, to file states correlated with past experiences. (We could not consciously reason about anything unless we could recall our past experiences and what others have told us.) (4) Brain states which give rise to desires good and evil. (Desires to eat and drink, to care for others or to hurt them; and to discover whether or not there is a God.) (5) Brain states caused by many different purposes which we have.[1] (6) A processor to turn these states into limb and other voluntary movements (to turn, for example, my purpose of telling you that today is Friday into those twists of tongue and lip which will produce an English sentence with that meaning.)

A universe will be hospitable to human bodies if the laws and boundary conditions are such that at some time or other humanoid bodies will occur.[2] By its "boundary conditions" I mean the overall features of the universe not determined by its laws but which together with its laws determine which states it can occupy. In a universe having a beginning, its boundary conditions will be tantamount to its initial conditions, such as — in our universe — perhaps the density of mass-energy and the initial velocity of its expansion at the time of the Big Bang. In a universe without a beginning, its boundary conditions will be tantamount to those features which it has at one time and which in virtue of its laws it will therefore have at all times — perhaps for example, the total quantity of its matter-energy. By "the universe" I mean our universe; and by that I mean the system of physical objects spatio-temporally related to ourselves. To make exposition clearer, I shall assume initially that the universe began with a Big Bang, but I shall drop that assumption in due course.

Clearly the universe is tuned. To say that it is fine-tuned is to say that the values of the constants of its laws and of the variables of its initial conditions needed to lie within very narrow ranges if humanoid bodies were ever to exist. Whether that is so depends on what are its fundamental laws and initial conditions, and how the 'ranges' thereof are to be measured. If the fundamental laws and initial conditions are, as we have tended to suppose, the laws of Quantum Theory with four forces, and the initial conditions are such conditions as the velocity, density and degree of isomorphism of the matter-energy of the universe immediately after the time of the Big Bang; and these are measured in normal ways, then — recent work has shown[3] — the universe is very fine-tuned indeed. But maybe the laws of Quantum Theory derive from more fundamental laws which have the consequence that the more readily observable variables can only take certain values. And different ways of measuring values will have different consequences for when a range is narrow. We will return to these points later.

For the purposes of a short paper, I need to make certain assumptions. The first is that either theism or naturalism is true. Theism is the claim that there is a God — a personal being, omnipotent (able to do everything logically possible), omniscient (knowing everything logically possible to know) and perfectly free (subject to no non-rational influence on how he acts, that is, no influence apart from any influence from his seeing what there is reason to do or not to do). Naturalism is the claim that physical laws and boundary conditions of the Universe bringing about a variety of effects, good and bad, are the ultimate determinants of what happens. Theism holds that in so far as laws and boundary conditions determine what happens, they do only in so far as God causes them to do so (and he may act other than through these means). I ignore, therefore, the possibility of intermediate theories — of weak gods, or many gods. In my view (for which I do not argue here), the probability of such theories is (on available evidence) very low.[4]

The second assumption is that a God (if there is one) has good reason for bringing about humanoid beings and so good reason for bringing about humanoid bodies. He may also have good reason for not bringing humanoids about, e.g. because of the evil they may do. But, since he is subject to no non-rational influences, let's say that there is a moderate probability that God will bring about humanoids and so humanoid bodies. This assumption is a crucial one, which I believe to be true; it does however, require argument, but there is no space to give it here.[5] If God is to produce humanoid bodies, he must also produce a law-governed universe in which different mechanisms produce good and evil effects, in which humanoids can exercise their powers.

Now possible explanations of phenomena are of two kinds: inanimate and personal. Inanimate explanations of a phenomenon e explain its occurrence in terms of prior conditions, and a law of nature from which it follows that those prior conditions will be followed by e. We explain a body falling to the Earth's surface in 2 seconds by it being liberated 64 ft. above the Earth in a vacuum tower (prior conditions) and the (derived) law of nature that all bodies near the surface of the Earth have an acceleration *in vacuo* of 32 ft/sec.^{2} towards the Earth. Laws may be deterministic (i.e. making the effect inevitable) or probabilistic (giving a probability other than 1 or 0 to the occurrence of some effect). Personal explanations of a phenomenon e explain it in terms of a person (or other animate being) who intentionally brought e about in virtue of his powers (to bring about effects), his belief that doing so would achieve some goal and his purpose of achieving that goal. The occurrence of the sound 'Yes' coming from my mouth when you ask me if I would like a drink is explained by me bringing it about intentionally, my belief that doing so will lead you to give me a drink and my purpose of having a drink. We use explanations of one or other pattern to explain mundane phenomena.

I suggest that a proposed explanatory hypothesis h (of either pattern) of some phenomenon or datum e (our evidence to be explained) is rendered probable by e in so far as (1) h makes e probable, (2) not-h makes not-e probable, (3) h has significant prior probability. These factors have to be weighed against each other, and those familiar with Bayes's Theorem will know that it provides a precise way of doing this. Let us represent by k anything else apart from e that we know about the world, our 'background evidence'. P(h | k) is then the prior probability of h given k alone, (its probability before we know e). P(e | h & k) is the posterior probability of e, the probability of e if h is true (given also k). P(e | k) is the prior probability of e, its probability if we do not assume h to be true. That equals its probability given k if h is true, plus its probability given k if h is false; P(e | k) = P(e | h & k) P(h | k) + (e | not-h & k) P(not-h | k).
Then Bayes's Theorem says:

$$P(h \mid e \,\&k) = P(e \mid h \,\&\, k)\, P(h \mid k) /\ P(e \mid k)$$

Of course, we cannot normally give exact values to most of these terms. But we can often give rough values to three of the terms, such as 'high', 'very low', 'greater than so-and-so', and that suffices to give a rough value to the remaining term.

I understand by the 'scope' of a hypothesis how much it tells you; a hypothesis has wide scope in so far as it tells you about many objects and tells you precise values of their properties. When we are dealing with a hypothesis h of narrow scope — telling us, for example, the mass or location of a planet of some particular distant star — then apart from our observations of the motions and spectra changes of that star (e), which h purports to explain, we have an immense amount of background evidence about how objects have behaved in neighbouring fields of inquiry indicating how they are likely to behave in this field, relevant to determining the mass and location of the planet. We have all the evidence over many centuries which led to the establishment of Newton's laws as the laws governing (approximately) the mechanics of medium-sized objects. And we have now quite a bit of evidence about the distribution of planets and their masses in other planetary systems, making it to some extent probable that the distribution in the planetary system in question will fit one of a small number of patterns. But the greater the scope of a hypothesis (the more it tells you about more objects), and so the more evidence it seeks to explain, the less will be the evidence from neighbouring fields — because the less neighbouring fields there will be. A hypothesis which seeks to explain the motions of all planets has moved all evidence of observations of planetary systems from k to e. But when, like Newton, we seek a general theory of mechanics to explain all mechanical phenomena; and if, like Newton, we have little by way of apparently relevant data about non-mechanical phenomena, there is little contingent background evidence. A 'Theory of Everything' will have no contingent background evidence by which to determine prior probability. Prior probability must then be determined by purely a priori considerations.

These a priori considerations in my view are two — scope and simplicity. The greater the scope of a hypothesis, the less probable it is — the bigger and more detailed your claim, the more probable it is that you will have made a mistake somewhere. And the simpler a theory, the more probable it is. The simplicity of a theory, in my view, is a matter of it postulating few (logically independent) entities, few properties of entities, few kinds of entities, few kinds of properties, properties more readily observable, few separate laws relating few variables, the simplest formulation of each law being mathematically simple.[4] One formulation of a law is mathematically simpler than another in so far as the latter uses terms defined by terms used in the former but not vice versa. Mathematical operations can then be ordered in terms of simplicity — addition is simpler than multiplication, multiplication than powers; scalars than vectors, vectors than tensors, and so on. This requirement also has the consequence that simpler theories use small integers rather than large integers, and integers rather than integers followed by a complicated fraction. Thus for phenomena made equally probable (to the degree to which we can make measurements) we should prefer the hypothesis of an attractive force between objects inversely proportional to r^2 (the square of their distance apart), rather than one inversely proportional to $r^{20..(\text{one hundred zeros})..01}$. Interestingly, however, hypotheses attributing infinite values of properties to objects are simpler than ones attributing large finite values. For we can understand, for example, the notion of an infinite velocity (the velocity being greater than any number of finite units velocity) without needing to know what the googleplex is ($10^{10^{10}}$). And scientific practice shows this preference for infinite values over large finite values of a property. It was preferred to postulate that light had an infinite velocity rather than a particular large finite velocity — e.g. 300, 000 km/sec., until data were found which were very improbable on the former hypothesis. But note that the preference for the infinite over the large finite applies only to degrees of properties and not to numbers of independent entities. This difference arises, I suppose, because degrees of properties merge so as not to act independently — you cannot divide a velocity of 4 ft./sec. into two individuatable velocities of 2 ft./sec. A velocity is a whole in the way that, say, a number of separably individuatable planets are not. So, for example, we must not postulate more planets than are necessary to explain the motion of observable stars.

In assessing the simplicity of a scientific theory, in terms of the mathematical simplicity of its equations, scientific practice shows that we must use the simplest formulation of that theory. A theory telling us what entities there are, what properties they have and how they interact may be formulated in many different ways — that is, by means of many different but logically equivalent equations. "$x = y$" is equivalent to "$x = y + (dy^3/dy)$ — $3y^{2+C}$"and more generally to its conjunction with the most complicated mathematical theorem. But it is by its simplest formulation (e.g. the former in the example) that we judge the simplicity of a theory. It lays bare the forces at work. When we are dealing with personal explanation, the requirement of simplicity requires us to ascribe higher prior probabilities to hypotheses postulating few persons, with similar and constant powers, beliefs, and purposes (or ones changing in accord with a constant formula).

My account of what are our criteria of simplicity was derived by me from considering cases where we judge one hypothesis in science or history or detective work more probable than a different one of equal scope which gives equal probability to the evidence requiring explanation (where there is no background evidence which will discriminate between them).

The account which I extrapolate from such cases may not be perfectly correct. But clearly there must be an all-important a priori criterion for judging between hypotheses of equal scope which give equal probability to the evidence, for there are always an infinite number of such hypotheses (for any degree of probability you choose), which make utterly different predictions from each other about what will happen tomorrow. Suppose that Newton's laws give a significant degree of probability to a vast number of observable data. Then so will a theory that has instead of Newton's law of gravity $F = mm'/r^2$, the law $F = (mm'/ r^2)+ (B\, m^{24}\, m'^{24}/ r^3)$ when B is a constant which has the value of 0 until the galaxies are a certain average distance apart (the distance that they will reach tomorrow) and then a positive value varying with that distance. Only a priori considerations (not unnaturally described as considerations of 'simplicity') justify the choice of Newton's theory over the alternative. And without them any prediction about what will happen tomorrow will be as well justified as any other. I suggest that my account of the criteria of simplicity is roughly correct. Both naturalism and theism are theories of everything of equal scope, and so only considerations of simplicity can determine their prior probabilities.

You might think that that is a reason for avoiding such theories, and considering only theories where prior probability can be determined by contingent background evidence without such a priori inputs. Unfortunately, that is not possible. When we are dealing with a narrow theory, the a priori element comes in to assessing *how* the contingent background evidence determines the prior probability of a hypothesis. Suppose that we are considering rival hypotheses to explain a monthly periodic shift in the spectrum of light coming from some distant star, and a monthly periodic movement of the angular location of the star (e). Given Newton's theory of gravity, given the theory that light travels in straight lines, and given the theory showing how the spectrum of light from one planet or star varies with its chemical constitution, our evidence e will be made very probable by a hypothesis (h) that a 'gas giant' planet revolves around the star each month. The 'background evidence' k which makes e make h probable is all the various data which make Newton's theory and the other auxiliary theories probable. But, as we have noted, the only reason why that evidence renders Newton's theory probable rather than any rival theory of equal scope which renders that evidence equally probable, is that Newton's theory is simpler. And the same goes for the other auxiliary theories. Given some theories rival to our auxiliary theories, the 'gas giant' hypothesis would not be in the least probable. Simplicity is an all-important a priori criterion for science, and without it science (or any true belief at all about what will probably happen tomorrow) would be totally impossible.

We have now in place the probability apparatus which will enable us to approach the central issue of this paper. Let e be the evidence of tuning, h the hypothesis of theism, h* the hypothesis of naturalism, and k tautological background evidence. Given my first earlier assumption that theism and naturalism are exclusive alternatives, $h^* \Leftrightarrow$ not-h. Given my second assumption that there is a moderate probability that a God will bring about humanoid bodies, $P(h|e \& k)$ will have a moderate value, let's say 0.2 or 0.3. (God may bring about humanoid bodies either by special creation or by making the boundary conditions such as to bring them forth from preexisting matter by the operation of laws of nature). h and h* being hypotheses of equal scope (telling us about everything), $P(h|k)$ will depend only on how simple is the hypothesis of theism, and $P(h^*|k)$ will depend on how simple is the hypothesis of naturalism. $P(e|h^* \& k)$ is the probability that if naturalism is true, the laws and initial conditions will be such as to lead to the evolution of humanoid bodies.

The crucial value in which we are interested — $P(h|e \& k)$ depends on the relative probabilities of $P(h|k)$ and $P(h^*|k)$, $P(e|h \& k)$ and $P(e|h^* \& k)$, not on the absolute values involved. The issue is — given that something does exist, is it more probable a priori that there exist a God than that there exist (uncaused by God) a physical universe of many physical substances all behaving over endless time in accord with exactly the same laws? And this, we have noted, turns on the relative simplicity of the two hypotheses. Theism is the theory of the existence of one entity, a personal being with the properties of omnipotence, omniscience and perfect freedom. To be a person a being has to have powers, beliefs and purposes. We human persons have limited powers, beliefs about some matters only (some of these beliefs being true, some false), and purposes greatly influenced by genes and environment (i.e. we are only partly free). God is supposed to have unlimited powers (there is nothing logically possible that he cannot do), true beliefs amounting to knowledge about all things (logically possible to know), and purposes uninfluenced by considerations other than those of reason. As I noted earlier, an infinite degree of a property is always simpler than some finite degree.

Relative to theism, naturalism is a complicated hypothesis, For it postulates, as the ultimate starting-point of explanation (its 'uncaused cause') either (what we have now) a very large number of entities behaving in exactly the same way (codified in 'laws of nature'), or fewer entities — in the extreme case, one extentionless particle — with the liability to produce many entities. The latter variant would be simpler in having few entities — in its extreme form only one entity; but the entities would need to have a very special set of properties built into them if they were to have a propensity to give rise to a uniform law-governed universe containing mechanisms to produce good and evil effects; and so the supposition of their existence would be a very complicated one.[7] Either way $P(h|k) > P(h|{}^*k)$ for tautological k. (Given my second earlier assumption that God has good reason for bringing about humanoids and so humanoid bodies, he has good reason for bring about the necessary condition for that — a law-governed universe. So we don't need to build into 'God' any additional propensity to produce such a universe).

What finally about $P(e|h^* \& k)$? If naturalism was true, what is the probability that the universe would contain humanoid bodies? This is the probability that the laws and initial or other boundary conditions of the universe would be such as — at some time or other — to lead to the evolution of humanoid bodies. As I wrote earlier, given Quantum Theory and the four forces etc., — let us call all this together the 'standard theory' — and no more ultimate explanation of the latter, and given the normal way of expressing the laws and of measuring initial conditions, the tuning is fine-tuning. And such fine-tuning is a priori very improbable. For the form of theories, including the standard theory, which scientists state in their books and articles is the simplest form — they don't try to complicate things for themselves and their readers unnecessarily. The simplest form of a theory is that form in which we judge the simplicity of the theory, which measures (for theories of equal scope) the a priori probability of its truth; the simplest form of a theory being that which scientists use involving variables and constants measured in the normal way. Versions of this form will differ only in respect of the values of constants of laws and of variables of boundary conditions therein. Given all that, a version which claims that a constant or variable lies within one range will not differ greatly[8] in simplicity from theories which claim that it lies within another range of equal size. But they will differ greatly in scope. A theory which claims that the value of some constant lies between 2 and 3 will be much less probable than one which claims that it lies between 4 and 10, the former being more precise and so having greater scope than the latter.

In slightly more technical terms the claim is that the probability density for constants and variables measured in the normal way is roughly constant. It is worth noting the effect of not choosing the simplest formulation of a theory, on the probability density of different constants and variables. I take a very easy example. Newton's law of gravitational attraction $F = G\,mm' | r^2$ could be expressed as $F = mm' | d^3 r^2$ where d is defined as $G^{-1/3}$. A constant probability density distribution for d will not yield a constant probability density distribution for G, and conversely. A constant probability distribution for d will yield the result that d is equally likely to lie between 1 and 0.5 as between 0.5 and 0, and so that G is equally likely to lie between 1 and 8 as between 8 and ∞ (i.e. to have any value whatsoever above 8). Expressing the laws of our standard theory in very complicated forms, logically equivalent to their simplest forms, and assuming a constant probability density for the constants and variables of these forms, could have the consequences that much greater variation of these (far less 'fine-tuning') would be compatible with the Universe being hospitable to humanoid bodies. But laws are judged simpler and so to have greater prior probability in virtue of the features of their simplest forms. Since a constant is simpler than a constant to a power, the traditional form of Newton's law is the simplest and so most fundamental form. And, more generally, insistence on the simplest form of a law should yield a unique probability density distribution for the constants and variables of laws of that kind (or, at most, if there are a number of equally simple forms of a law, a few different probability density distributions which are not likely to make much difference to the extent of the need for fine-tuning).

So given the standard theory, and no more fundamental explanation thereof (physical or theistic), tuning is a priori immensely improbable.[9] But there may be a more fundamental physical theory which explains the standard theory, and a constant probability density for the constants and variables of the boundary conditions of its simplest form may have different consequences for the a priori probability of tuning. And more generally, there are innumerable possible scientific theories differing in their form from each other, and innumerable different kinds of boundary conditions differing in the number of entities which they postulate (big and small universes), each allowing many different sets of constants and boundary condition variables. A constant probability density over the latter (when each theory is expressed in its simplest form), will yield a different probability for each theory that a Universe conforming to it will be tuned. The theories (although of equal scope — telling us about everything) themselves will differ in their simplicity, and so in their prior probability. Hence, given a precise way of measuring simplicity, and so given that the infinite number of possible theories can be ordered in respect of simplicity, there will be a true value for the prior probability (given naturalism) that a Universe is tuned. It will be (loosely) the proportion of logically possible universes which are conducive to the evolution of humanoid bodies, each weighted by the simplicity of the laws which govern it and the parcity of entities in its boundary conditions. So it does not matter — for the purposes of an argument from fine-tuning — whether we have the correct theory of our universe, or whether there is a more ultimate physical explanation of the forces that govern it. For the prior probability (given naturalism), that a universe will be tuned is not a function of the physical theory and boundary conditions which governs our universe, but of all the possible theories and boundary conditions there are. It is not, however, within my ability to calculate this value, nor — I say with some confidence — within the ability of any present-day mathematician.

But what, I suggest, is fairly obvious is that *no* relatively simple universe would be tuned. For consider the six features of a humanoid body listed at the beginning of this paper. Such a body has parts. But the parts have to form one body distinct from other bodies, and the inanimate world. In our world this is secured by a chemistry whereby only some bits of matter link to other bits of matter — if I put my hand into a sandpit, my hand will not absorb the sand; but if I eat some bread it will become part of my body. Sense-organs require an enormous variety of stimuli impinging on a place, which vary with their distant source. In our universe the best of all such stimuli are light waves — an enormous variety of different light waves arrive every second at our eyes, which vary with the states of objects many metres away. The sense organs respond differently to each very small range of incoming stimuli. But we humans are only interested in certain aspects of the states of distant objects — whether they are the bodies of predators, or prey or mates, and so on for a million possible differences. The stimuli have to cause brain states which give us the information which interests us. Our information processor will utilize states caused by past experiences to secure this. And if we are not to be just automata but to reason consciously from past experiences, we need a memory bank to file those in recoverable form. This requires a chemistry of stable states (so that memories remain the same as time passes) and metastable states so that certain kinds of input will move a brain element from one state to another (as we learn that some previous belief was erroneous). And for output we need again, an enormous variety of brain states corresponding to the different purposes we could form, a processor to turn these into the relevant limb movements (e.g. if I want to tell you that today is Friday, to produce the twists of tongue and lip that will cause the appropriate sounds of the English language). And we need a stable inorganic world to which we can make a difference which remains — no point in trying to build a house if the bricks immediately liquidify. One way in which all this could be achieved would be by bodies composed of only a few particles, each capable of existing in a trillion trillion trillion different states. But a physics which allowed such particles would be of incredible complexity. The other way, the way operative in our universe, is to have extended bodies, each composed of many fundamental particles of a number of different kinds, each particle capable of undergoing a few different discrete states; the differences between bodies being a matter of the number and arrangement of the units and the discrete states of each. To do the job this way you need a universe with a very large number of particles — to compose many bodies and an inanimate environment through which people may influence each other. Change has to be affected through a particle (or group of particles) changing their states, causing other particles to change their states. To secure stable bodies which are nevertheless capable of existing in many different states, you need more than one simple force. One simple force of attraction would lead to crushed lumps of matter incapable of sensitive reaction; and one simple force of repulsion would lead to there being no extended bodies at all. Minimally a combination of two different simple forces (possibly both derivable from one more complicated force) is required. A force of attraction between particles inversely proportional to the square of the distance apart of the particles would be required to be balanced, for example, by a force of repulsion inversely proportional to the cube of their distance apart. Forces of these kinds of the right strength would lead to particles coming together but not collapsing on top of each other. But to preserve states (of belief for example) intact, we have to rule out small variations. We need metastability — systems which remain unchanged under forces of a certain strength but which change from one discrete state to another discrete state when the strength of the force exceeds a certain amount. This is ensured in our universe by the laws of Quantum Theory which guarantee the stability of the atom. And to have distinct bodies which do not merge with each other, and distinct brain states which are only open to change under certain kinds of input we need something like a chemistry allowing substances to combine easily with some substances but not with other substances. This is secured in our universe by chemical substances different from each other by the charge on their nucleus and the arrangements of charge-balancing electrons in shells around the nucleus — in other words, protons, neutrons and the Pauli principle. And so on. So we need large numbers of particles of a few different kinds and forces of some complexity acting between them. But universes are simpler, the fewer objects (e.g. particles) they contain and the fewer kinds of mathematically simple forces which operate between them. *No* very simple universe could be tuned, whatever its boundary conditions. Clearly more complicated kinds of possible universes (e.g. ours) can be tuned, and maybe that requires fine-tuning. Maybe, too, some very complicated kinds of universe would produce humanoid bodies for most values of constants and variables of boundary conditions. But the considerable a priori weight of simplicity suggests that given naturalism, it is a priori improbable that any one universe will be tuned so as to yield humanoid bodies. $P(e \mid h^* \& k)$ is very low.

Of course, if there was an infinite number of universes, each with different laws and different boundary conditions, one might expect at least one to be fine-tuned. But it is the height of irrationality to postulate an infinite number of universes causally unconnected with each other, merely to avoid the hypothesis of theism. Given that simplicity makes for prior probability, and a theory is simpler the fewer entities it postulates, it is far simpler to postulate one God than an infinite number of Universes, each differing from each other in accord with a regular formula uncaused by anything else.[10] There might, however, be particular features of our universe (other than its tuning) which are most simply explained by supposing that it "budded off" from another universe in virtue of a law whereby universes produce daughter universes differing from them in boundary conditions and laws; and so our universe is explained as one of a causally connected collection of an infinite number of universes differing from each other in boundary conditions and laws. But that is tantamount to postulating a multiverse which has laws and boundary conditions such that it will contain at some time or other a tuned universe. But then there are an infinite number of logically possible multiverses which do not have this characteristic, and the shape of the problem has in no way changed by postulating more universes. Although the shape of the problem has not changed, it is possible that the proportion of the range of possible multiverses (weighted by their simplicity) which give rise to at least one tuned universe, is greater than the proportion of the range of possible universes (weighted by their simplicity) which are tuned. But since the simpler multiverses will produce only a small range of simple universes (e.g., ones governed by simple laws, varying in respect of the constants of those laws), the probability that there will be a multiverse yielding a tuned universe remains very low.

I conclude that the prior probability of theism is much higher than that of naturalism, and that the probability given naturalism of a tuned universe is very low. Hence, given my initial assumption that given the existence of God, the existence of a tuned universe is moderately probable, the tuning of the universe gives by itself a considerable probability to the existence of God — quite apart from the probability arising from other evidence.

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NOTES

1. Note that I do not equate brain states with purposes or beliefs. I only insist that they be casually connected with them.

2. For the sake of ease of exposition, I am presupposing that any universe is either predetermined to produce humanoid bodies, or predetermined not to do so. My account needs to be nuanced in obvious ways, which do not affect its structure or conclusion, to take account of universes having various physical probabilities intermediate between 1 and 0 of giving rise to humanoid bodies at some time or other.

3. See the full exposition of this work in J. D. Barrow and F. J. Tipler, *The Anthropic Cosmological Principle*, Clarendon Press, 1986. The "inflation" hypothesis, in its many variants, looks as if it can be successful in removing the need for fine-tuning from the initial conditions only by putting it into the laws. (See J. Earman and J. Mostevin, "A Critical Look at Inflationary Cosmology," *Philosophy of Science* (1999), 1-49.) But maybe it won't turn out that way, and the inflation hypothesis will reduce somewhat the need for fine-tuning.

4. Basically, for the reason that theories of weak gods and many gods are less simple theories than the theory of one omnipotent etc. God. See my *The Existence of God*, revised edition, Clarendon Press, 1991, pp.94 and 141.

5. For a brief defence of it see my "The Argument to God from Fine-Tuning Reassessed" in (ed.) N. Manson, *God and Design*, Routledge, forthcoming; and for the particular point that having a body is a good for finite rational beings and so that God has reason to create embodied rational beings, see my "What is so good about having a body?", in (ed.) T. W. Bartel, festschrift for Keith Ward, SPCK, forthcoming.

6. Scientists do, of course, put forward hypotheses using moderately complicated mathematical equations relating values of properties ('isospin', 'hypercharge' etc.) not readily observable. My point is simply that, other things being equal (i.e. among hypotheses equally able to explain the phenomena), simpler hypotheses relating properties more readily observable are more probably true. For a fuller account of the criteria of simplicity and their role in science,

see my *Epistemic Justification*, Clarendon Press, 2001, chapter 4.

7. On this see further my "Argument from Laws of Nature Reassessed" in (ed.) M. Stone, *Reason, Faith, and History*, Ashgate, forthcoming, and in (ed.) W. Demski and M. Ruse, *Debating Design: From Darwin to DNA*, Cambridge University Press, forthcoming.

8. It will differ a little if the simplest formulation of the theory yields a unique zero point for measurement (a unique point at which some quantity has its lowest value), as for example does the Kelvin scale for Temperature measurement, (0°K being that temperature at which an ideal gas would exert no pressure, and no lower temperature is possible). For then lower ranges are a priori more probable than higher ranges, for the reason that laws containing smaller integers are simpler that ones containing larger integers. It is for this reason that low values of the constants and variables with which we are concerned are more probable a priori than high ones, that the probabilities that the values of the constants and variables lie within finite intervals have finite values. But if a range of one formulation of given size having high values is equivalent to a range of the same size of another equally simple formulation having low values and conversely, then the probability of a value of a variable lying within a high range measured in the former way will be the same as its probability lying within a low range of the same size measured in the same way. It is often equally simple to express a theory in which there is a variable of the distance on a line between A and B, by measuring that distance with A as the zero point or by measuring it with B as the zero point.

9. In order to show the improbability of tuning it is not enough to show that tuning is improbable given the standard theory, that is given the local area of possible words. John Leslie has compared this fine-tuning to a dart hitting a cherry on a wall when there are no other cherries in that area of the wall. He claims that (on the assumption that hitting a cherry is something a dart-thrower might wish to do) the fact that the dart hit the cherry is evidence that it was thrown intentionally by a dart-thrower – even though there are many cherries on other areas of the wall. (See p. 143 of his "Anthropic Principle, World Ensemble, Design," *American Philosophical Quarterley* 19 (1982), pp. 141-52). His claim seems to depend on a feature of his analogy, to which there is no parallel in the universe fine-tuning case. A dart-thrower would naturally try to hit a cherry in an area of a wall a long way from other cherries; his aim being to hit a cherry when that would be difficult for the average human dart-thrower. Hence he aims at the isolated cherry, rather than at cherries close to other cherries. A God tuning a universe seeks to produce humanoids; he has no particular concern to produce them in a possible world very unlike other possible worlds (except the very closest ones) — he has no concern to show his universe — tuning skills, only to bring about an end-product. So if the fact that there is a tuned universe is to be evidence for God being its creator, what has to be shown improbable a priori, is not that there be a tuned universe in our local area of possible worlds, but that there be a tuned universe among all possible worlds. I have given some argument for this — from the impossibility of any very simple universe (and so any universe a priori relatively probable) being tuned.

10. Max Tegmark has, however, claimed that it is simpler to postulate an infinite number of universes than just one. See Max Tegmark, "Is 'The Theory of Everything' merely the Ultimate Ensemble Theory?", *Annals of Physics* 270 (1998), 1-51, p. 38 – "Our TOE [Theory of Everything] ... postulates that all structures that exist in the mathematical sense, exist in the physical sense as well. The elegance of this theory lies in its extreme simplicity, since it contains neither any free parameters nor any arbitrary assumptions about which of all

mathematical equations are assumed to be 'the real ones'". He explicitly (his p. 44) assumes an account of simplicity, according to which a theory is simpler the fewer the number of computational symbols needed to express that theory. This 'algorithmic' account has the consequence that, for example (p. 44), the "set of all perfect fluid solutions to the Einstein field equations has a smaller algorithmic complexity than a generic particular solution, since the former is specified simply by giving a few equations and the latter requires the specification of vast amounts of initial data on some hypersurface." So it is simplest of all to postulate that every possible universe exists, since that needs very few computational symbols indeed to state!

Tegmark's account of simplicity seems to me to yield in this case a bizarre result, totally out of line with all our inductive practice. If we are postulating entities to explain phenomena, we postulate the fewest number of entities needed to do the job. In any case the supposition that all possible entities exist is incoherent. For the existence of some entities rules out or makes undetermined the existence of others. Thus, the existence of an omnipotent all-good God rules out the existence of an omnipotent Devil (in any universe at all). And given the former, God will certainly not choose to bring about the existence of certain other states — e.g. endless suffering unchosen by the sufferer. And quite apart from the account of the simplicity of a theory (in terms of the fewness of computational symbols needed to express it) which led to the claim that it is simple to suppose that every possible universe exists, it needs considerable amplification. For how many symbols you need to express something depends on the language you use. All theories can be expressed in the form "a = b", when 'a' and 'b' represent some highly complicated multi-dimensional tensors, yet which expressed in this way use only three symbols; but, of course, it needs a language far removed from the language of observation to express the theory in that way. Tegmark's account of simplicity is not a clear one and its consequence in the case of current interest to us is bizarre and contains a contradiction.