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Do Many Worlds Make Light Work?

In the light of the lessons of history following the work of such scientists as Copernicus and Darwin, Christian scientists may be wary of condemning scientific theories as unscriptural or unchristian. Nevertheless it is not inconceivable that, as physics becomes entwined with cosmology, some physical theories or metatheories will eventually conflict with some key Christian doctrines. Multiverse theories are no longer merely the stuff of science fiction but are regarded by some physicists as logical extensions of viable theories and by others as fanciful speculation. Whereas attention so far has focused on their ability to solve the fine-tuning problem, this article examines some of the theological implications should one or more of them be considered valid.

Key words: creation, everything, fine-tuning, gap, multiverse, random, universe, worlds

Terms and concepts

The word 'universe' was originally used to mean 'all that exists'. Multiverse theories therefore introduce a linguistic difficulty similar to that caused by the term 'subatomic'. But the substitution of the word 'multiverse' to mean 'all that exists' would be ambiguous (see below). To avoid this problem I will follow a scheme analogous to that used by Bernard Carr[1] and use 'Universe' to denote all that exists, and 'universe' to denote all that may in principle be accessible to a specific observer.[2]

The term 'multiverse' is used in physics for a number of concepts with different meanings and implications. This can be the source of some confusion. Max Tegmark has produced a 4-level classification scheme[3] to distinguish among them. The headings are derived from his work.

Level I – Beyond Our Cosmic Horizon: Inflation theory was developed to solve problems in the Big Bang Theory (BBT) of the overall homogeneity and density of the Universe.[4] It requires that the Universe has virtually critical density and therefore a flat space-time geometry, which implies that it is infinite. Within such a Universe observation is

1 Carr, B. (ed.) *Universe or Multiverse?*, Cambridge: Cambridge University Press (2007), xv.
2 Even this definition is not quite watertight, as it may be possible for some universes to interact gravitationally.
3 Tegmark, M. 'Parallel universes', *Scientific American* May 2003.
4 Guth, A.H. 'The inflationary universe: a possible solution to the horizon and flatness problems', *Phys. Rev.* (1981) *D* 23, 347.

limited to a spherical 'Hubble volume' or 'horizon volume' with a radius determined by the distance light has travelled during the lifetime of the universe.[5] We are by definition at the centre of our universe, but other such universes obviously exist with the same physics but different initial conditions. The Universe is only a multiverse by virtue of observational limitation.

Level II – Other Post-Inflation Bubbles: (a) In a multidimensional space-time it would be possible to have 'bubble multiverses' with different dimensionalities and/or physical constants.[6] One way that these could arise could be through a process of Chaotic Inflation, according to which a pre-existing space-time undergoes inflation at different rates in different regions. In some places inflation ceases, allowing the formation of island Level I multiverses in an untraversable sea of continuing inflation.[7] Another multiverse-spawning suggestion is the ekpyrotic brane collision theory based on the currently popular M-theory.[8] (b) Temporally separated multiverses, such as Lee Smolin's Cosmic Natural Selection,[9] Roger Penrose's Conformal Cyclic Cosmology,[10] and Loop Quantum Cosmology[11] may also be included in this level as they can produce ensembles which are indistinguishable from those that are spatially separated.

Level III – Many Quantum Worlds: The difficulties in accepting the probabilistic nature of quantum mechanics have led some to adopt a view in which the universe can be represented by a real, non-collapsing, 'universal wave function' that evolves deterministically in time.[12] The different options described by any quantum process, such as the radioactive decay, or not, of a nucleus, then lead to a superposition of non-interacting 'worlds', or splitting of 'realities'. What we regard as our universe is just one branch of this ever-bifurcating superposition.

5 The age of the universe is currently believed to be 13.7Gy, but the radius would be greater than 13.7Gly because of the expansion of the universe during the time that the light has travelled. Current estimates are about 47Gly, but this is somewhat misleading because we do not observe to that distance.

6. Throughout this article the term 'physical constants' refers to quantities such as a) the force coupling constants, e.g. the fine-structure constant $\alpha=e^2/2\varepsilon_0 hc$ expressing the strength of electromagnetic interactions, (b) the masses of fundamental particles, (c) cosmological environment 'constants', e.g. the vacuum energy density.

7 Linde, A.D. 'Eternally existing self-reproducing chaotic inflationary universe', *Phys. Lett.* (1986) *B* 175, 395-400.

8 Lehners, J-L., McFadden, P. & Turok, N. 'Colliding branes in heterotic M-theory', APS *Phys. Rev.* (2007) D75, 103510.

9 Smolin, L. *The Life of the Cosmos*, Oxford: Oxford University Press (1997).

10 Penrose, R. *Before the big bang: An outrageous new perspective and its implications for particle physics*, Edinburgh: Proceedings of EPAC (2006), pp. 2759-2767.

11 Bojowald, M. 'Loop quantum cosmology', in Ashtekar, A. (ed.), *100 Years of Relativity. Space-Time Structure: Einstein and Beyond*', Singapore: World Scientific (2005).

12 Everett, H. 'Theory of the Universal Wavefunction' Thesis, Princeton University 1956.

Branches start off with just one small difference, such as the liveliness of Schrödinger's cat, but rapidly diverge, as in the butterfly effect.

Level IV – Other Mathematical Structures: We can imagine universes that are governed by other laws, and even at times have believed in such laws (e.g. strict Newtonian mechanics). Tegmark himself suggested that any mathematical representation should, somewhere, have a physical realisation.[13] This may sound like metaphysical speculation, but for Tegmark it is based on an even more radical view, namely his Mathematical Universe Hypothesis, that our physical world is actually an abstract mathematical structure.[14]

A marriage made in heaven

A possible lay reaction to the idea of multiverses is that they are too speculative to be taken seriously, and so could not constitute a significant challenge to theology. How did physics get involved with multiverses? It will be helpful to summarise the direction that physics has taken from quantum theory onwards, in order that their cogency may be seen.

1. Twentieth century physics was revolutionised by the introduction of Quantum Theory (QT),[15] Special Relativity (SR),[16] General Relativity (GR),[17] and Matter Waves (MW).[18]
2. QT was developed mathematically into matrix mechanics by Heisenberg, and MW into wave mechanics by Schrödinger. These were shown to be equivalent by Schrödinger and Dirac,[19] and the resulting formalism is now known as Quantum Mechanics (QM).
3. QM is highly successful, but is burdened with philosophical difficulties of interpretation.
4. The traditional or Copenhagen Interpretation requires a belief that the wave function describing the probabilities of the state of a physical system 'collapses' at the moment of observation, yielding a unique solution which must now be described by a new wave function. This casts doubt on the physical reality represented.
5. The simplest interpretations that attribute full reality to the wave

13 Chown, M. 'Anything goes', *New Scientist* 6 June 1998.
14 Tegmark, M. 'The Mathematical Universe', *Founds. Phys*. November 2007, 116.
15 Planck, M. 'Über das Gesetz der Energieverteilung im Normalspektrum', *Annalen der Physik* Leipzig (1901) 4, 553.
16 Einstein, A. 'Zur Elektrodynamik bewegter Körper', *Annalen der Physik* (1905) 17, 891.
17 Einstein, A., 'Die Grundlage der allgemeinen Relativitätstheorie', *Annalen der Physik* (1916) 49, 769.
18 Broglie, L.de 'Recherches sur la théorie des quanta', Thesis, Paris (1924); *Ann. Phys*. Paris (1925) 3, 22.
19 Dirac, P.A.M. *Principles of Quantum Mechanics*, Oxford: Oxford University Press (1930).

function and avoid collapse are those based on Everett's Relative State Formulation[20] of QM, the most well-known and popular of which is the Many Worlds Interpretation (MWI).

6. Extending QM to the description of forces produces Quantum Field Theories (QFTs). The first QFT was Quantum Electrodynamics (QED).[21] The quantisation of fields requires the existence of exchange particles. Thus electromagnetic forces are mediated by photons.
7. The discovery of the Cosmic Microwave Background Radiation[22] established BBT as the preferred cosmology, and quark theory brought order to particle chaos.[23] The timeline could now be pushed back from nucleosynthesis[24] (~3 minutes) to quark confinement (~1μs). The relationship between the physics of the very small and the very large was firmly established.
8. Subsequent cosmologies sought to address difficulties within BBT, such as the singularity and the flatness and uniformity problems, and also issues of fine-tuning.
9. Unification theories have simplified the physics of interactions previously treated as distinct, for example, electromagnetism,[25] and the electroweak interaction.[26] At present there is no generally accepted Grand Unification Theory of the electroweak and strong interactions, the latter being described by Quantum Chromodynamics. The ultimate goal of some physicists is to achieve a Theory of Everything, bringing gravity into the scheme, but this is a still more remote possibility because as yet there is no generally accepted QFT of gravity, which is described by the highly successful theory of GR.
10. QFT and GR are incompatible. The most popular theory so far that can reconcile them is superstring theory, which as yet has no other supporting evidence.
11. There are five versions of string theory, each describing all fundamental particles (including exchange particles) in terms of small strings with different vibration modes in a 10-dimensional space-time. This is at variance with an 11-D theory of 'Supergravity'.

20 Everett, H. '"Relative state" formulation of quantum mechanics', *Reviews of Modern Physics* (1957) 29, 454-462.
21 Schwinger, J. 'Quantum electrodynamics. I. a covariant formulation', *Phys. Rev.* (1948) 74, 1439–1461, and others.
22 Penzias, A.A. & Wilson, R.W. 'A measurement of excess antenna temperature at 4080 Mc/s', *Astrophysical Journal* (1965) 142, 419.
23 Gell-Mann, M. 'A schematic model of baryons and mesons', *Physics Letters* (1964) 8 (3), 214-215.
24 Alpher, R.A., Bethe, H. & Gamow, G. 'The origin of chemical elements', *Physical Review* (1948) 73 (7), 803-804.
25 Maxwell, J.C., 'A dynamical theory of the electromagnetic field', *Phil.Trans. Roy. Soc.* (1865) 155, 459-512.
26 Weinberg, S. 'A model of leptons', *Phys.Rev.Lett.* (1967) 19, 1264-1266, also Glashow, S. & Salam, A.

12. By extending the dimensionality of string theories to 11, M-theory, though still incomplete, appears to promise a unifying theory of superstring theories.[27]

It can be seen that the Level III multiverse makes its appearance at (5), and Level I & II multiverses appear at (8). We shall now look at issues of consistency between Christianity and multiverse proposals, which I will take at face value in order to concentrate on these issues.

Level I: Hubble volumes

Level I 'universes' are not very controversial. Their only claim to being regarded as separate universes is based on their unobservability from a neighbouring Hubble volume. Even the concept of the Hubble volume is a subjective one because the position of an observer defines the volume; an observer halfway along the radius of our Hubble volume will define a different volume which overlaps one of our neighbours. All volumes share the same physics and can differ only in initial conditions and evolution. Possibly the only issues that arise concern duplication – from individuals at one end of the scale, to entire universes at the other.

One of the popular implications of the Universe being infinite is that in some other universe there *will* be your exact double, or 'doppelgänger'.[28] The argument is statistical. In an infinite Universe even a possibility that has infinitesimal probability will occur somewhere. Thus somewhere the laws of physics have contrived to reproduce your doppelgänger, particle for particle. Tegmark even goes so far as to estimate the probable distance of your nearest twin, namely $10\text{^}10^{29}$ metres.[29] A similar calculation for an entire duplicate universe gives a distance of about $10\text{^}10^{115}$ metres. These are inconceivably huge distances,[30] hence the confidence that you will not find your double in our own Hubble volume. But regardless of distance,

27 Witten, E. 'Magic, Mystery and Matrix', *Notices of the AMS* October 1998, 1124-1129. The 'M' is often understood to stand for 'Membrane', but was intentionally left ambiguous to allow for other references.

28 These could in principle exist even within a single universe, although the probability is unimaginably small.

29 Tegmark, M., 'Parallel universes', in Barrow, J.D. Davies, P.C.W. & Harper, C.L. (eds.), *Science and Ultimate Reality: Quantum Theory, Cosmology, and Complexity*, Cambridge: Cambridge University Press (2003). Even assuming the exact flatness and therefore infinitude of the Universe, I am not convinced by Tegmark's 'crude estimate', which is a particles-in-slots argument, and gives no consideration to the possible processes and associated probabilities which put them there.

30 There is no distance ratio in our universe that can be compared with the factor by which the smaller of these two distances exceeds the radius of the observable universe. Note that the numbers are double exponents. Let us represent $10\text{^}10^{29}$ by R_d, the observable universe present radius, $\sim 10^{26}$m, by R_u, and the proton radius, $\sim 10^{-15}$m, by R_p. $R_u / R_p = 10^{41}$. To reduce R_d to R_u, our universe would have to be shrunk to the size of a proton, and *repeatedly shrunk by this same factor* about 10^{27} times [actually $(10^{29} - 26)/41$ times].

does the supposed existence of such a person constitute any threat to your identity?

Christians who believe in some form of substance dualism are unlikely to be worried. Perhaps my dual looks and behaves much like an identical twin, but no one ever suggested that identical twins in this world raise theological difficulties. My dual does not have my soul and even if he has similar predispositions to me I would not believe that he is *bound* to make the same choices as I do, at all times, and if he does so, they are *his* choices. But what if you are a monist, if even a dual-aspect monist? One of the 'assurances' of the monist is that in the Resurrection God is capable of *recreating* a person, because the body has been destroyed and there is no immortal soul. In an earlier article I have objected to this argument on the ground that 'the pattern is not the person'.[31] But if a human being is entirely defined physically, there is nothing else but the pattern. In what sense is your 'alter ego' not you? A monist therefore might legitimately be worried that her doppelgänger is in some sense an identity thief. Worse still, if only one of the two is necessary in order to define and preserve the person, then the other is dispensable. In the Resurrection, a single body would serve for both, but whose consciousness would it have?

Other issues of a similar nature can be raised, but they are also based on this 'infinite statistical materialism' – what can happen, will happen, somewhere, sometime. Duplicating our planet's history would require, for example, a re-enactment of the Incarnation, and whilst this is not prohibited by theology (in my opinion[32]), it is not a consequence of cosmological evolution. Nor can we prescribe to God how he should interact with another world, however closely it parallels our own. In countering such arguments, a Christian is not really objecting to the multiverse, but to the accompanying philosophy. Materialism and monism are problems in any universe.

Level II: (a) bubbles and branes

Unlike those in Level I, universes in Level II may have different dimensions, physical constants and apparent physics. At the most fundamental level the physics is assumed to be the same, but many of the laws that we commonly use to describe physical phenomena are 'effective' laws and may be scale or condition dependent. Effective laws are those that are consequent on the effect of circumstances on more fundamental physics – for example, the way in which it is supposed that initial conditions have determined the symmetry-breaking, or 'freezing out', of the four basic in-

31 Turl, E.J. 'Substance dualism or body-soul duality?', *Science and Christian Belief* (2010) 22 (1), 68.

32 Turl, E.J. 'All Things New', *Science and Christian Belief* (2007) 19(2), 153.

teractions (electromagnetic, gravity, strong, weak). The search for unified theories underlines a belief that effective laws may derive from overarching fundamental laws.

Superstring theories require the existence of a ten-dimensional space-time for consistency. M-theory extends this to eleven. To explain why we perceive only three dimensions of space, it is assumed that the remaining dimensions are 'curled up' extremely tightly for any entity in the space-time, giving such objects a multidimensional 'inner space'. There are many combinations of ways in which this 'compactification' can be done, and the nature of the inner space would determine the values of otherwise apparently arbitrary physical constants. Thus a universe and its physical laws would be defined by its compactification and resulting effective dimensionality. This 'string landscape' is estimated to allow in the range of 10100 to 101000 such possibilities.

Chaotic inflation provides a possible mechanism by which different effective laws and physical constants may arise from the same fundamental physics. The description of the process as 'chaotic' implies that inflation of space-time might not be uniform, but rather exhibit random variations. In the same way that a cooling magma can produce different crystalline forms, both in crystal composition and size, depending on the rate of cooling, it is imagined that the nature of the inflation and its eventual cessation could result in different ways in which freezing out could occur in the birth of a Level I multiverse. Thus Linde concludes: 'As a result, our universe at present should contain an exponentially large number of mini-universes with all possible types of compactification and in all possible (metastable) vacuum states consistent with the existence of the earlier stage of inflation'.[33]

M-theory has been used to propose another possible mechanism. In this theory a universe may exist on a p-dimensional[34] membrane or 'brane' within the eleven-dimensional space-time or 'bulk'. Consider now the possibility that two similar 3-branes are separated by a comparatively small distance in a fourth spatial dimension. Gravitational attraction[35] could cause them to collide inelastically, some of the kinetic energy being converted into matter, resulting in localised ekpyrotic 'big-bang-like' events.[36] There is likely to be rippling of the branes as they approach due to quantum irregularities. This would result in some parts colliding before others, causing the observed local inhomogeneities in matter distribution and energy. In this model there is no singularity, no superluminal expansion,

33 Linde, A.D. *op. cit.*, (7).
34 'p' refers to the number of *space* dimensions.
35 Graviton exchange would not be restricted to the spatial dimensions of the source brane.
36 Takamizu, Y. & Maeda, K. 'Particle production in a two-brane collision and reheating of the brane universe', *IoP Journal of Physics, Conference Series 31* (2006), 177-178.

and no uniformity problem.[37] Any number of branes may exist with different dimensionalities and compactifications, so collisions would produce universes with different physical laws and constants. Many of these may be unsuitable for producing 'life as we know it'. For example, we require a four-dimensional space-time to produce inverse square law force fields, without which stable orbits would be impossible, in which case we could not have atoms, let alone planetary systems.

It has been known for some time that a number of physical constants, some theoretical and some environmental, give the appearance of being very carefully chosen to permit life to develop in our universe.[38] This has been viewed by many Christians as evidence for a God of design,[39] and by atheists (or perhaps better, scientists who do not want to invoke a God as part of the scientific description of creation) as either an anthropic selection,[40] or an incompleteness of theory.[41] Level II multiverses appear to offer a solution to the fine-tuning problem by proposing that there actually exists a multitude of such universes that have different initial conditions and constants, so that it is meaningless to ask of any one universe why its laws are what they are. They will be different in any of the other universes and in an effective infinity of universes almost all conceivable law combinations will be represented.

A multiverse theory that offers a fine-tuned universe as a random occurrence among many other badly-tuned universes may therefore be seen as a gift to unbelievers: 'One does not need any more to assume that some supernatural cause created the Universe with the properties specifically fine-tuned to make our existence possible'.[42] I shall not consider here whether a multiverse proposal adequately solves the fine-tuning problem, a subject that has been critically addressed by Rodney Holder.[43] There are serious questions relating to the meaningfulness of infinite creation and whether even then the measure of life-supporting universes could be non-zero, but it is the job of the quantum cosmologist to produce something superior to the current hand-waving arguments. Rather I shall focus on whether it is reasonable to believe that God might create a multiverse when he could have made a single fine-tuned Universe. Does it look as if Christians are on the back foot as their God is threatened with exclusion from yet another gap?

37 The movement of the *intersection* between 2 colliding surfaces can have *any* speed because it is not a physical entity.
38 Davies, P. 'How bio-friendly is the universe?' *International Journal of Astrobiology* (2003) vol. 2, no. 2, 115; Hawking, S. *A Brief History of Time,* Toronto: Bantam (1988), p. 125; Rees, M. *Just Six Numbers*, London: HarperCollins (1999).
39 e.g. W.L. Craig, R. Holder, J. Polkinghorne, R. Swinburne.
40 e.g. Weinberg, S. 'Living in the multiverse', in Carr, B. (ed.) *op. cit*., (1), p.39.
41 e.g. Wilczek, F. 'Enlightenment, knowledge, ignorance, temptation', in Carr, B. (ed.) *op. cit.*, (1) p.49ff.
42 Linde, A. 'The inflationary multiverse', in Carr, B. (ed.) *op. cit.*, (1), p.135.
43 Holder, R.D. *God, the Multiverse, and Everything*, Farnham: Ashgate (2004).

Even though the concept of cosmological fine-tuning is relatively recent to the scientific community and therefore not one of the classical gaps that God was assumed to inhabit, it might be regarded as a foregone conclusion that God would need to construct a single Universe carefully if evolution was to be the instrument of creation of life. So the possibility that he used a multiverse of which a single component had 'by chance' the right parameters might seem to be an unnecessary extravagance. However, on reflection it might be considered to be no more so than many of the proliferations that are apparent in the natural world, both in its evolution and in its routine cycles of life. Robin Collins sees it as an example of the infinite creativity of God.[44]

A parallel might also be drawn with the creation of the elements needed for life, understood to be the products of stars, in which the heavy elements up to iron are created by fusion in stellar cores, and the heavier elements in addition in the final collapse of supernovae. This also is an extremely extravagant way of producing what we need, but it can be viewed without dishonesty as the plan of an extremely generous and ingenious God, who will create an entire universe as the means of achieving his goal of intelligent, rational, moral life. The fact that the method he chose produced not only the essentials but also an entire spectrum of elements that we can use as our playground or workshop for scientific discovery and technological development further shows the wisdom of the method. It also reveals an important attribute of a God who genuinely wants to see what his creatures can accomplish rather than watch them act out a play of his own scripting.

Similarly, it is conceivable that a purpose might be found in a multiverse in which one or comparatively few universes are, from our present point of view, useful or productive. How can we be certain that universes which are inaccessible to us now will continue to be so after 'all things are made new' (Rev. 21)? It would be very rash, at this stage of our ignorance, to judge that a multiverse is no more useful than a single correctly-tuned Universe. We should also acknowledge that God may have other reasons for creating universes than meeting the needs of living things. We tend to adopt a very anthropocentric view of God's creative activity, almost as children consider their parents to exist for their benefit, and not to have a life of their own. Yet as adults we often pursue creative interests as valid ends in themselves that do not have utility as a necessary justification. Why should it seem strange if God, in whose image we are made, should enjoy the creation of a multiverse, only some components of which will be used to produce and sustain life?

It might be objected[45] that the overwhelming majority of universes

44 Collins, R. 'The multiverse hypothesis: a theistic perspective', in Carr, B. (ed.) *op. cit.*, (1).
45 I am grateful to one of the referees of this article for raising this issue, which has prompted this and the next paragraph.

in such ensembles would be uninteresting, with the implication that it would not be consistent with God's nature to create them. However, it is important not to confuse interest with purpose. Interest presupposes the associated existence of interested beings, in both senses of their ability to contemplate and to benefit from their host world, but purpose can exist in a wider context. There are places and entities even within our own universe to which we might struggle to attach any interest, but it would be a mistake to suggest that they should not have formed part of God's creation. They are part of the scheme of things, for which there is an overarching purpose. Interest is of course, like beauty, in the eye of the beholder. Some human beings might struggle to find interest in either positrons or Pluto; others, such as Paul Dirac and Clyde Tombaugh, may devote a significant proportion of their lives to their study. If human interest is of such a variable nature it would be presumptuous to prescribe the limits of the divine analogue.

A more serious objection is that a random ensemble might contain unacceptably evil universes. In our present state of ignorance we cannot know whether the supposed laws that would govern the range of universes that any given ensemble could contain would allow an infinite continuum or a discrete, even if large, set of components. Logically, the former should pose the greater theological threat, but even the latter does not appear to guarantee that all physically possible universes would be theologically defensible. This should sound a note of caution. Even if the existence of a Level II multiverse is in principle not theologically controversial, it cannot be assumed that any proposed theoretical framework for its creation will necessarily be so in practice. Christians who favour multiverses will still have to keep a watchful eye on multiverse theorists. Professor Keith Ward has commented thus:

> Augustine also thought of the possibility that there might be 'worlds without end', that is an infinite number of different universes (bk.12, ch.19), though he was reluctant to decide on the issue. Where saints hesitate, cosmologists rush in to assert the existence of many universes.… If God is indeed perfect beauty and bliss, it seems most plausible that God will allow those possible universes to exist that meet the conditions of the principle of plenitude. There will be many possible universes that God would not permit to exist, since they contain too much unredeemed evil. But it may be in the nature of God, as self-realising pure actuality, to allow into actuality, to 'let be' (Gen. 1:3) all possible worlds that are overwhelmingly good, and in which evil and suffering are necessary conditions of greater good for sentient beings in those worlds.[46]

However, it is possible that the spectre of innumerable hellish worlds

46 Ward, K. 'Cosmology and creation', Gresham College Lecture (Notes), November 2004.

is overrated or simply unjustifiable. The fine-tuning argument provides grounds for believing that we need certain very precise conditions for life to develop at all. There is no corollary that says that off-tuned universes will result in beings that suffer unacceptable pain, and there are no theories in existence that give any clue to what type of world we might live in if the tuning were different. It should be remembered that there are plenty of places in our own finely-tuned universe that would be intolerable to life, but that is precisely why there is no life there.

Did God use many worlds to make light work of the fine-tuning problem? Did he hedge his bets when he said 'Let there be light', that the light would work in at least one universe? Theists as well as atheists might question whether God would have used a multiverse when his omniscience must have allowed him to create a single Universe with the right parameters. But it is clear from nature that it pleased God to create our universe in a way that did not need interference to make it work. A Universe that is designed to do everything according to built-in laws is superior to one that requires divine input. It is cleverer. Ironically, the scientist who does not want God to be necessary to preset parameters should not, to be consistent, object to a God who holds similar views.

Level II: (b) birth and rebirth

The multiverses of Smolin and Penrose are better described as conjectures than theories, whereas that of Ashtekar and Bojowald evolved from the theory of Loop Quantum Gravity, developed by Ashtekar, Smolin and Carlo Rovelli as an alternative approach to the problem of reconciling QED with GR. All three consist of Level I multiverses that are time-sequenced, exponentially in the case of the first and linearly in the other two.

In the Cosmic Natural Selection (or Fecund Universe) of Lee Smolin, it is proposed that black holes are the seeds of new multiverses, and that each child multiverse differs slightly in physics from its parent. As a result, some of the multiverses may be better than others at producing the kind of stars that end up as black holes, and it is these that will reproduce more multiverses. This is a form of natural selection. But living things also depend on the very same kind of stars for their existence, since a Type II supernova also produces and disperses the heavy elements required for life during core collapse. Hence cosmic natural selection would favour those values of physical parameters that are also suitable for life, making it unnecessary to appeal to the strong anthropic principle.

In the Conformal Cyclic Cosmology of Roger Penrose, it is surmised that the ultimate fate of our Level I multiverse might be total heat death, all massive particles having decayed to photons (requiring new physics), or perhaps having fallen into black holes that evaporate by Hawking radiation. In the absence of particles there would be no remaining definition of

time or space. Relativistically a photon takes no time in its own reference frame to travel from one place to another, and distance is infinitely contracted. The multiverse therefore becomes the potential seed for another big bang.

In the Loop Quantum Cosmology of Abhay Ashtekar and Martin Bojowald the singularity of Big Bang theory is replaced by a Big Bounce at the end of the Big Crunch of a previous Universe. This would have occurred as the density of the latter reached the Planck density, ~10^{96} kg/m^3, and would have lasted about 10^{-43} of a second, the Planck time. Opinions differ as to whether the bounce would preserve any information from one Universe to the next,[47] so the contribution of the theory to the fine-tuning discussion is uncertain.

Two possible issues arise from such ensembles. The first is that in all cases it is possible to assume an absence of beginning or end. The buck of explanation is passed from the physics of first creation to the philosophy of eternal existence. For the atheist it seems that this is a preferred problem. It has similarities to the difficulty of understanding the eternal existence of God, but it is perceived to keep the problem 'in-house'. It is deemed better to be left with the philosophical problem of 'Why is there something rather than nothing?'[48] than to have a physical problem with a supernatural solution. But for the Christian it matters little where the line is drawn; on the desk in God's white house the sign still says 'The buck stops here.' Traditionally the concept of an eternal physical universe has not been considered a theological problem. Thomas Aquinas argued that 'there is no contradiction in saying that something made by God has always existed'.[49] Whether it is possible philosophically to conceive an infinite causal chain is another matter.

The second issue is essentially the same as that of biological evolution. Can biblical creation be read consistently with an evolutionary process, and does the latter imply any incongruities with the revealed attributes of God? Since the Bible says even less about the cosmology of creation than it does about its biology, it seems unlikely that Christians who have already accepted evolutionary biology and the evolutionary cosmology of Big Bang theory would find any reason to object to the additional evolution of the multiverse. It might, for example, be considered quite reasonable that God would create a Universe that has an inbuilt tendency to generate multiverses that in turn have inbuilt tendencies to produce life. It might take a little longer, but time is hardly of the essence.

47 Bojowald, M., 'Quantum nature of cosmological bounces', *Gen. Relativ. Gravit.* (2008) 40, 2659-2683;Corichi, A. & Singh, P.., 'Quantum bounce and cosmic recall', *Phys.Rev.Let.* (2008) 100, 161302

48 Leibniz, G.W. *The Principles of Nature and Grace, Based on Reason*, (1714).

49 Aquinas, T. *De Aeternitate Mundi*, ('on the eternity of the world'), (1271).

Level III: quantum worlds

Hugh Everett III developed his Relative State Formulation of Quantum Mechanics while at Princeton University working for his PhD. In essence his formulation proposes in the first place that an observer is not to be regarded as an independent external entity to an observed physical system, and, secondly, that whenever the wave function describing a quantum event leads to more than one possible measurable outcome, for example the measurement of the spin direction of a fundamental particle, both possibilities continue to exist. The implication is that every outcome will have a correlated observer state. What is not certain from Everett's paper is how the different observer states translate into experience. Everett himself did not pursue an academic career, and it has been left to others to interpret or expand on his ideas. It is this ambiguity that has led to a number of derivative interpretations, the Many Worlds Interpretation[50] being the most favoured as being the most purely physical.[51] In this interpretation, if a measurement is made on a quantum system existing initially as a superposition of states, each state will give rise to a different measurement. This apparent contradiction is resolved by a 'splitting' of worlds into orthogonal and mutually unobservable 'copies', owing to decoherence of the wave function. In each world there is a copy of the observer who has made a different determinate measurement. As there is a huge number of such events occurring all the time in every such world, the number of worlds rapidly increases to an unimaginably large value.

The unavoidable question for Christians is whether the language of MWI can be applied to important events and processes in Christianity without doing violence to theology. Roger Paul[52] and Rodney Holder[53] in *Science and Christian Belief* 2005, 17(2) are two authors who have already wrestled with a number of issues, some of which with additions of my own are given below.

1. When an observer splits, are the different instances the same person? More than one person in parallel worlds in my future can identify

50 DeWitt, B.S. 'The many-universes interpretation of quantum mechanics', in d'Espagnat, B. (ed.) *Foundations of Quantum Mechanics*, New York: Academic Press (1971).
51 The Bare Theory (Albert, D.Z. & Loewer, B. 'Interpreting the Many Worlds Interpretation', *Synthese* (1988) 77, 195-213) requires a belief that observers are deluded, undermining any possibility of supportive evidence. The Many Minds Interpretation (Zeh, H-D. 'On the interpretation of measurement in quantum theory', *Foundations of Physics* (1970) Vol.1, Issue 1, 69-76) requires a belief that observers have an infinity of minds, dualistically distinct from the brain, which supervene on the superposition of brain-states, and from which a choice is made of a determinate result.
52 Paul, R.P. 'Relative state or it-from-bit', *Science and Christian Belief* (2005) 17 (2), 155-175.
53 Holder, R.D. 'God and differing interpretations of quantum theory', *Science and Christian Belief* (2005) 17 (2), 177-185.

with me in my present world. How are they related to each other?[54] If you believe in substance dualism, what happens to the soul when an observer splits?

2. Are moral decisions in any way related to quantum events? It would be unacceptable in any interpretation of QM to make quantum events the primary cause of moral decisions, because this would rob them of significance and responsibility,[55] but if any choices are associated with quantum events it is possible that different decisions are realised in different worlds. This would appear to make it unnecessary for me to worry about which choice I make, because all options will be realised.[56] As the MWI is completely deterministic, it is difficult to see how any freedom, moral or rational, could be attributed to the human will in such a multiverse. For every quantum event that is subject to a measurement, each element of its superposition would be entangled with a corresponding observer brain-state. This would generate a conscious mental state over which the epiphenomenal 'I' would have no control.
3. If a person is saved, is he/she saved in all worlds? For a Calvinist, does not the doctrine of election require all person-derivatives of an elect person to be saved? For a non-Calvinist, might you not sin in one world in the confidence that grace will abound to you in another?[57]
4. If Christ was 'tempted as we are' (Heb. 4:15), then his choices must have the same status as ours. This means that he would have been just as subject to splitting as we are. Can we believe that Christ 'bifurcated' into multiple persons, some of which would have yielded to temptation?
5. How could God interact sovereignly with a universe where all outcomes are realised? Fulfilment of prophecy would seem to be possible only in some branches of reality. For some minor prophecies, different interpretations might 'save the day', but not for major events such as the nativity and the crucifixion.[58] Do such events happen in more than one world?[59] Are there some worlds in which they do not happen at all?
6. Whatever views one holds on the problem of evil,[60] it would seem that there is no possible theodicy where all possible histories occur.

54 Paul, R.P. *op. cit*., (52), 165.
55 Turl, E.J. 'Substance dualism or body-soul duality?, *Science and Christian Belief* (2010) 22 (1), 58.
56 Paul, R.P. *op. cit*., (52), 165.
57 Holder, R.P. *op. cit*., (53), 180.
58 Paul, R.P. *op. cit*., (52), 166,167.
59 Holder, R.P. *op. cit*., (53), 179.
60 For relevant views of the author, see Turl, E.J. 'Theodicy & Geodesy', *Science and Christian Belief* (2011) 23 (1).

Tegmark has argued that the intuitive rejection of MWI that we feel, is unjustified since all Level III universes can be reproduced in Level I. But this argument only works if Level I is thoroughly materialistic and if decision-making and the continuity of self in Level III have no significance. I do not object to my doppelgänger making a different life-choice from mine, but I do object if my splitgänger does so, because I believe he has an equal claim to be derived from my pre-decision self as I now do. I have a strong feeling that he made the decision that I did not want to make.

Both Paul and Holder seem uncomfortable about the implications of MWI for theology, but are cautious in passing judgement. This is understandable because MWI was largely ignored by physicists in the 1960s and is still regarded by many as either speculative or unacceptable, so why tilt against windmills? Also it is likely that Christians in science nowadays may be unwilling to repeat the mistakes of the past by making premature condemnations of what may one day turn out to be the prevailing scientific view. However, MWI is now regarded as a mainstream alternative to the Copenhagen Interpretation so it is probably high time for Christians to say what they think. We believe that scientific fact cannot threaten belief, but it would be dangerous to allow the pendulum of reaction to swing so far that we are prepared to accept any interpretation of any theory regardless of its implications for theology. Conversely, if we think that Christianity should not set itself up against MWI, it is incumbent on us to produce a compatible anthropology and Christology. If that seems impossible it may be inevitable that the Christian should feel obliged to adopt one of the other QM interpretations,[61] and be prepared to say why, or invent another!

Level IV: mathematics and metaphysics

Tegmark's Mathematical Universe Hypothesis (MUH) is based on two premises, the first of which is that our physical universe is a mathematical structure – a Theory of Everything – and that its 'physicalness' is created by self-aware structures (such as us) within it.[62] The second premise is that any other consistent mathematical structures have an equal democratic status, and therefore correspond to other universes. Space does not permit[63] in this article a full discussion of Tegmark's ultimate multiverse,

61 A useful summary & list of sources is at: http://en.wikipedia.org/wiki/Interpretations_of_quantum_mechanics. If a time-asymmetric interpretation is required with a non-collapsing physical wave function that does not give rise to alternative realities, the only candidate at present would appear to be the de Broglie-Bohm formulation, helpfully introduced at http://plato.stanford.edu/entries/qm-bohm/.

62 The resemblance of this to the scenario presented in the film 'The Matrix' is obvious.

63 I also omit discussion of another mathematical proposition, the Holographic Universe, which is better described as an 'alternative' or 'parallel' universe than a multiverse. For a brief account, see Greene, B. *The Hidden Reality*, London: Penguin (2011), chap.9.

the justification for which is much more metaphysical than for those in the lower levels. But his own interpretation of the MUH must surely ring alarm bells for Christians, if it really means

> that mathematical equations describe not merely some limited aspects of the physical world, but *all* aspects of it, leaving no freedom for, say, miracles or free will in the traditional sense.[64]

The MUH certainly raises very interesting questions, such as those regarding the nature of physical reality and its dependence or otherwise on conscious observers, and whether or not it is *meaningful* to distinguish between a simulated universe and a real one, let alone possible to determine which is the case for us. Whether a different interpretation from that quoted would be possible while preserving the fundamental philosophy is open to debate, but it would have to be asked whether scientific or theological motivation could be found for such an exercise since it is not clear whether there is any pay-off in terms of solving known physical problems.

Theories of everything

It is thought by some physicists that M-theory might be the 'holy grail' of physics, namely a Theory of Everything (TOE). In particle physics the term referred originally to a unified theory that would include gravity,[65] 'everything' referring to all interactions and particles. It might be questioned whether a theory of *pure* physics should be concerned with cosmological history, any more than it would be with the formation of the solar system. But if any of the free parameters have been determined or affected by early processes it is understandable that the TOE should be involved.

The original Big Bang theory had a number of difficulties: the Planck era, from the singularity to approximately 10^{-43} of a second was inaccessible to physics, and there was no explanation for the observed uniformity of the universe. Theories that have been developed since to address these problems push the horizon of explanation beyond the fine-tuning question to that of origin by invoking the physics of spontaneous creation.[66] Two issues underlie this idea, namely the source of the mass/energy, and the mechanism of creation. The problem of the source is, surprisingly, the simpler of the two to answer. It is easy to posit a scenario in which matter and

64 Tegmark, M. 'The multiverse hierarchy', in Carr, B. (ed.), *op. cit*., (1).

65 Ellis, J. 'The superstring: theory of everything, or of nothing?', *Nature* (1986) 323, 595-598.

66 Tryon, E.P., 'Is the universe a vacuum fluctuation?', *Nature* (1973) 246, 396; Vilenkin, A., 'Creation of universes from nothing', *Phys. Lett.* (1982) 117B, 25; Linde, A.D., 'Eternally existing self-reproducing chaotic inflationary universe', *Phys. Lett.* (1986) 175B, 395-400; Gorsky, A.S. 'Spontaneous creation of the brane world and direction of the time arrow', *Physics Letters* B, Vol. 646, Issue 4, 15 March 2007, 183-188.

its associated energy sum to zero. If, for example, an electron and a positron are at rest and separated by a distance of approximately equal to the proton radius, their (negative) electrostatic potential energy $-e^2/4\pi\varepsilon_0 r$ will be numerically equal to their (positive) total rest energy $2mc^2$. Thus they possess, and in principle could have come from, zero energy. But could this be true on a cosmological scale for the much weaker gravitational interaction? Amazingly it seems that:

> In the case of a universe that is approximately uniform in space, one can show that this negative gravitational energy exactly cancels the positive energy represented by the matter. So the total energy of the universe is zero.[67]

This is supported by observational evidence:

> It is possible to settle the issue by a simple calculation. Astronomers can measure the masses of galaxies, their average separation, and their speeds of recession. Putting these numbers into a formula yields a quantity which some physicists have interpreted as the total energy of the universe. The answer does indeed come out to be zero within the observational accuracy…. If that is so the cosmos can follow the path of least resistance, coming into existence without requiring any input of matter or energy at all.[68]

A simple mechanism of primary creation can be based on the Uncertainty Principle, the relevant formulation of which is in this case: $\Delta E.\Delta t \geq \hbar$.[69] In a quantum vacuum this allows the continual creation of random particle-antiparticle pairs of rest energy ΔE for a period of time Δt, after which they annihilate. For an ensemble of particles to become permanent a model of universe creation would have to be constructed in which the borrowed energy is paid back within the allowed time in some other way, namely by attaining a zero-sum energy configuration.

Actual processes are obviously model-dependent and cannot be fully specified with certainty, which is unsurprising because particle phenomenology is incomplete. A typical approach in inflationary models is the postulation of an unspecified all-pervading scalar 'inflaton' field that drives the expansion until its potential approaches a minimum, after which the remaining energy is converted into elementary particles. In brane collision models, the positive energy needed for particle creation derives from the loss of gravitation potential energy as branes attract each other. But even if total energy is conserved at zero none of these scenarios could be

67 Hawking, S. *op. cit.*, (38), p.129.
68 Davies, P. *God and the New Physics*, London: J.M. Dent & Sons (1983), pp.31-32.
69 It may be argued that the UP does not actually reveal its mechanism, but only specifies its effects, which is that if a physical state exists for a period of time Δt then its energy is uncertain by an amount at least equal to ΔE.

described as creation *ex nihilo*. The price to be paid for getting the physics back into creation is in all cases an assumed multidimensional backdrop with its background laws – a primordial quantum vacuum.

The current tendency to look to M-theory for an encompassing description of creation is understandable because it appears to be able to unify string theories, where there is hope of constructing a quantum theory of gravity. But the idea that M-theory might be the long-awaited TOE is for some in the hopeful, and for others the doubtful, stage. The theory is nowhere near complete and it is not even yet known whether it will be possible to formulate it as a single theory or as a family of theories. By its very nature it is bound to offer more scenarios than can be realised in any one universe. It seems unlikely then that it will meet the expectations of those physicists who are looking for a unique unified theory. Its advocates are aware of this inbuilt limitation and are already preparing the scientific community for a let-down:

> We were looking for a unique and beautiful theory that would unambiguously predict the observed values for all parameters of all elementary particles, not leaving any room for pure chance.… If [the 'string landscape'] is correct, then physics alone cannot provide a complete explanation for all properties of our part of the Universe. The same physical theory may yield large parts of the Universe that have diverse properties.[70]

Undoubtedly, some will see this as an example of the seductive power of the anthropic principle.

The hand of God

What problem does a TOE create for theology if it claims that 'Spontaneous creation is the reason there is something rather than nothing, why the universe exists, why we exist'?[71] Anticipating the publication of *The Grand Design*, the following single explosive sentence made the media headlines: 'It is not necessary to invoke God to light the blue touch paper and set the universe going.' Going a step further in interview, Hawking was reported as saying 'One can't prove that God doesn't exist, but science makes God unnecessary. The laws of physics can explain the universe without the need for a creator.'[72] Contrary to some commentators' claims,[73] this was not a new stance. In *A Brief History of Time* Hawking had written:

> So long as the universe had a beginning, we could suppose it had a

70 Linde, A. 'The inflationary multiverse', in Carr, B. (ed.) *op. cit.*, (1), pp.127-128, 131.
71 Hawking, S. & Mlodinow, L. *The Grand Design*, London: Bantam Press (2010), p.180.
72 ABC News, 7 September 2010: http://abcnews.go.com/GMA/story?id=11571150
73 e.g. BBC News UK, 2 September 2010: http://www.bbc.co.uk/news/uk- 11161493, also Reuters.

> creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place then, for a creator?[74]

Just 'so long'? The Big Bang theory may have appeared to offer the hand of friendship to Christianity, but it is a relatively young theory and so was never a tenet of faith. *So much longer* had it been considered that the universe did not have a beginning, and yet still it was supposed that it had a creator. Aristotle believed it to be so,[75] and both Augustine and Aquinas acknowledged that there was no contradiction[76] even though they had other arguments to the contrary. Leibniz argued that:

> Things eternal may have no cause of existence, yet a reason for their existence must be conceived.… Hence it is evident that even by supposing the world to be eternal, the recourse to an ultimate cause of the universe beyond this world, that is, to God, cannot be avoided.[77]

He saw the distinction between physical cause within the system and reason for existence outside it. Keith Ward made a similar distinction when he said:

> Creation is not the beginning of the universe, and the question of whether there is a creation is not the question of whether the universe had a beginning. In fact, it's totally irrelevant to creation whether the universe – whether time – began or not.… Creation is the dependence of all space-time … upon some reality beyond space-time. More than that, of course, for creation, you have to say the relation is one which is intentional, that is, the reality beyond space-time which brings into being, and holds (in) being space-time has to do it on purpose.[78]

The blue touch paper is therefore unlikely to worry Christians who have already come to terms with a God who created *from outside* a universe that was capable of generating intelligence from particle chaos *according to a system of internal laws*. If our understanding of those laws can be revised to explain yet more, do we not simply have to acknowledge that God is even cleverer than we had envisaged? Regardless of one's beliefs or lack of them, a scientific theory is by definition only scientific in so far as it succeeds in explaining phenomena according to scientific laws and processes, however well-verified they may or may not be. It ceases to be scientific at the point where God's supernatural interference is invoked. For the scientific Christian, it will always be more attractive to seek a

74 Hawking, S. *op. cit.*, (38), pp.140-141. For someone in the Augustinian tradition, the answer would have been simple: 'Where he was before – outside.'
75 Aristotle *De Generatione et Corruptione*, Bk.II, cap.10, 336a 27-28.
76 Aquinas *op. cit.*, (49).
77 Leibniz, G.W. *On the Ultimate Origination of the Universe* (1697).
78 Ward, K. *op. cit.*, (46).

theory that does not require God to 'give the machine a push'. It does the mind of God greater justice.

It is not the first time that cosmology has spawned a statement about the need for God which has raised hackles. The French astronomer and mathematician Pierre-Simon Laplace developed Newton's mechanics, replacing the latter's geometrical reasoning with calculus, seeking to demonstrate that the stability of the solar system could be fully accounted for by physical laws, whereas Newton believed that occasional divine intervention was necessary to compensate for planetary perturbations. On the publication of his work Laplace was challenged by Napoleon that he had written a large book on the system of the universe without even a mention of its creator. Laplace's famous reply was 'Je n'avais pas besoin de cette hypothèse-là' ('I had no need of that hypothesis'). Atheists have seized on this remark as the archetypal rationalist reply to faith. But Laplace was correct. Newton had felt the need for periodic divine prods; Laplace had not.

Such a God-hypothesis is indeed unnecessary *within* any fully consistent and efficient theory. It is only from *outside* that the religious question may be asked. In the 1980s a poster became popular in academic laboratories depicting Maxwell's equations of electromagnetism, prefixed by the words 'And God said…' and suffixed by '… and there was light.' In my experience no one ever suggested that there was an inconsistency. But there is no mention of the speaker within the equations. It is this Thomist-Augustinian view of God as external to his creation, that is the ultimate answer to those who wish to put the Laplace-Hawking banner on the atheist bandwagon.

Mind the gap

The familiar and disparaging description of 'God-of-the-Gaps' theology did not originate from opponents of Christianity. The earliest approximation to the term was probably by the Scottish evangelist Henry Drummond (1851-97) who berated Christians whose God operated only in the parts that science could not yet reach. In the last of a series of lectures he championed evolution as God's chosen method of creation while distancing it from reductionist philosophy:

> There are reverent minds who ceaselessly scan the fields of Nature and the books of Science in search of gaps – gaps which they will fill up with God. As if God lived in gaps? What view of Nature or of Truth is theirs whose interest in Science is not in what it can explain but in what it cannot, whose quest is ignorance not knowledge … If God is only to be left to the gaps in our knowledge, where shall we be when these gaps are filled up? And if they are never to be filled up, is God only to be found in the disorders of the world? Those who yield to the temptation

> to reserve a point here and there for special divine interposition are apt to forget that this virtually excludes God from the rest of the process.[79]

In the last century the methodist mathematician Charles Coulson, in a book written to communicate the gospel to scientists, espoused the same view: 'There is no "God of the gaps" to take over at those strategic places where science fails; and the reason is that gaps of this sort have the unpreventable habit of shrinking.'[80] That the phrase is often misappropriated by atheists, who see it as a general failing of Christianity, is illustrated by one website[81], where Coulson's statement is misinterpreted and listed among 'well-known quotations in favour of atheism'.

The view that was the object of Drummond's attack was that nature itself has 'nomic gaps' in which God himself was needed to make up the shortfall of creation. For him this was an 'occasional-God' philosophy, which was far less noble than an 'all-God' philosophy; 'an immanent God, which is the God of Evolution, is infinitely grander than the occasional wonder-worker'. Even Newton's theology was deficient in this way as is revealed in this discourse:

> For while Comets move in very excentrick Orbs in all manner of Positions, blind Fate could never make all the Planets move one and the same way in Orbs concentrick, some inconsiderable Irregularities excepted which may have risen from the mutual Actions of Comets and Planets upon one another, and which will be apt to increase, till this System wants a Reformation.[82]

Leibniz would have none of this, and it is interesting to see what he allows, as much as what he condemns:

> Mr. Newton and his followers also have a very odd opinion about God's creation. According to them, God needs to wind up his watch from time to time, in order to prevent it from stopping. He didn't have enough vision to make it a perpetual motion machine. This divine machine is so imperfect (according to them) that he is forced to give it a regular service by a miraculous intervention; and even to mend it, as a clockmaker mends his products. But the more a clockmaker has to retouch and correct his work, the worse a craftsman he is. … And I hold that, when God performs miracles, this is not to fulfil the requirements of Nature, but those of Grace. To think otherwise would be to have a very mean conception of the wisdom and power of God.[83]

79 Drummond, H. *The Lowell Lectures on The Ascent of Man*, New York: James Pott & Co (1904), chap.10 'Involution'.

80 Coulson, C.A. *Science and Christian Belief*, London: Fontana Books (1958), p.32.

81 Arguments for Atheism: http://argumentsforatheism.com/quotes.html as seen 6/6/2011.

82 Newton, I. *The Third Book of Opticks*, 2nd edn., (1718), Qu.31.

83 Leibniz, G.W. Letter to Princess Caroline of Ansbach, November 1715

Thus Leibniz makes a category difference between a God-of-the-Gaps who makes up for a supposed incompleteness of natural law, and a Sovereign God who chooses to intervene in a perfected physical creation only for specific and unusual spiritual purposes.[84]

The crucial point of Drummond's thinking is that God's activity is not an *alternative* to that in nature which science can explain. God is not pushed out of the gaps because he did not leave any. It is absurd to think that his hand is to be seen only in what he has not designed, and not in what he has. Thus the advance of scientific knowledge does not push God into ever-diminishing pockets of ignorance. Rather, it diminishes our ignorance of God's method of working, provided we maintain a healthy humility towards the possibility that our increasing knowledge is always subject to revision.

Self-existence theories

To think that a TOE squeezes God out of the picture is essentially the result of thinking that a TOE is a Theory of *Existence*. To avoid such confusion I would prefer to call the latter a Self-Existence Theory (SET), in other words a theory, or more accurately a philosophy, by which it is claimed that the Universe can account for its own existence, by analogy with the use of the term in theology where it means that the ground of God's existence is within himself. In the same way that Drummond challenged Christians to abandon God-shaped gaps *within* science, I believe that we should be challenging the notion that science can answer the question, 'Why is there anything at all?'

The argument given in *The Grand Design* is that 'Because there is a law such as gravity, the universe can and will create itself from nothing'.[85] But why is there a law such as gravity? Because of M-theory (perhaps). Then why is there such a theory as M-theory? Even a basic multidimensional inflaton field must have its own 'background laws'.[86] If ever we reach the point where we can say that a certain theory is the final answer, we can ask the question again, but without the hope of getting a scientific answer. The question then has to leave the realms of science for those of philosophy.[87] It is logically impossible for a TOE to explain its own existence because physical laws are (mathematical) statements that relate physical

84 Turl, E.J. *op. cit*., (60): 'the miracles of Jesus … were performed for definite theological purposes … and not for theatrical effect or to compensate for deficiencies in the natural order'.

85 Hawking, S. & Mlodinow, L. *op. cit*., (71), p.180.

86 Collins, R. *op. cit*., (44).

87 Worryingly, the authors of *The Grand Design* claim that philosophy is dead (p.5), and that free will is an illusion (pp.31-32). One wonders if such an obituary is a little premature for a book whose authors *choose* to draw *philosophical* conclusions from scientific theories.

quantities, and you cannot write down a law unless you first have some quantities to relate.

There is a delightfully ridiculous scene in Milton's 'Paradise Lost' where the faithful seraph Abdiel reminds the angels that they are created beings, whereupon Satan asks

> who saw
> When this creation was? remember'st thou
> Thy making, while the Maker gave thee being?
> We know no time when we were not as now;
> Know none before us, self-begot, self-raised
> By our own quickening power …[88]

Something similar is happening when it is claimed that God could be made redundant by a sufficiently comprehensive scientific theory of spontaneous creation. I am not suggesting that there is here an infallible cosmological proof for the existence of God. Rather, his existence cannot be *disproved* by a self-consistent TOE because a TOE is an internal description of the laws of the Universe not an external one: a TOE cannot be a SET. It is a vain hope that the ultimate explanation will explain itself. Einstein is reported to have said 'What I am really interested in is knowing whether God could have created the world in a different way; in other words, whether the requirement of logical simplicity admits a margin of freedom.'[89] Even if a TOE is one day found that answers this question in the negative it would not be a SET. To achieve that status it would have to deny God not just the option of *what* to create, but also the option of *whether* to create.

Conclusion

Multiverse theories have enjoyed a resurgence in recent years because of the fine-tuning problem. Undoubtedly some of the motivation has been a desire to exclude God from the discussion. But confusion between the *causes of* and *reasons for* existence, and between the *beginning* and the *creation* of the Universe, seems to underlie claims that God is not necessary. Some Christian scientists are indeed well-disposed towards the possibility of some multiverses,[90] and it can be argued that 'theists might even have reasons for preferring a multiverse over a single universe',[91] which is ironic given the original motives for postulating their existence.

88 Milton, J. 'Paradise Lost', Book V, ll.853-858.
89 'Was mich eigentlich interessiert, ist, ob Gott die Welt hätte anders machen können; das heisst, ob die Forderung der logischen Einfachheit überhaupt eine Freiheit lässt', quoted by Ernst G. Straus (who was Einstein's assistant from 1944 to 1948), in Seelig, C., *Helle Zeit - Dunkel Zeit*, Zurich: Europa Verlag (1956), p. 72.
90 e.g. Stephen Barr, Don Page, Arthur Peacocke.
91 Collins, R. *op. cit*., (44).

A scientific spin-off from this might be that we can discuss the pros and cons of multiverse theories more dispassionately than would otherwise be the case.

However, reservations have been noted. In the Level I multiverse (and any other effectively infinite ensemble) there may be problems with the meaning of human identity specifically for those of monist persuasion. For the dualist this issue does not arise because every human soul is perceived to be unique and not a function of any assembly of particles. In the case of Level II multiverses a critical view needs to be maintained towards specific proposals, particularly if they achieve sufficient sophistication to make detailed description of alternative universes possible, some of which may be morally unacceptable. Level III and IV multiverses both raise additional difficulties. The Level III multiverse of MWI appears to be irreconcilable with the Christian world-view, especially in matters of identity and personality, and the Level IV multiverse seems to blur the line between reality and imagination, resulting in a proliferation of universes beyond the control of either creation or a creator. Tentatively in these two cases it is suggested that in making the transition from attempting description of physical reality by generating a mathematical structure to attempting interpretation of mathematical structure to generate a physical reality there is a progressive risk of diluting the gold standard of scientific enquiry: *evidence*.

The multiverse method of achieving fine-tuning may at first appear out of character for an almighty God. But it has to be asked whether this view is consistent for Christians who have already accepted that God can outwork his creative purposes through evolutionary processes in one universe. Some may worry that random compactifications and symmetry-breaking do not seem like a recipe for guaranteeing good universes, but we are not yet in possession of the final TOE, which may reveal more constraint on free parameters than we expect. It would not be surprising to discover some new principle of quantisation that severely restricted the range of possibilities. It is a curious paradox that we usually consider randomness to be antithetical to divine plan. Einstein objected to quantum mechanics on the ground that 'God does not play dice.' Undoubtedly, the omniscience of God and nomic regularity have contributed to that belief. But the world would be an impoverished place without randomness, and modern physics shows that this is not incompatible with overarching regularity. Infuriating though it may be at times, quantum mechanics[92] is the source of much essential complexity and desirable interest in nature;[93] dangerous as it

92 or more correctly, the (probably incomprehensible) reality that QM attempts to describe.
93 Prof. Don Page has pointed out in refereeing this article that 'if indeed God used the Everett version of quantum theory, He could have produced the complexity, beauty, and diversity that we observe without having anything random or outside His determination by divine plan and nomic regularity'. If so, I would have to accept that the divine randomness reappears from *my* viewpoint in the form of *which* branch I happen to inhabit.

is, radioactivity is key to our environment and has great power for good. We also see abundant evidence that beauty and diversity, both recognised as goods, cannot achieve full expression without randomness. It is common experience that it is a central ingredient of such human activities as games, discovery, invention and artistic inspiration.

How can these things be if randomness finds no parallel in the attributes of God? It is true that randomness in human behaviour often assumes a defective guise, such as capriciousness or aggression, but this happens when it is unbridled and unevaluated, and does not mean that there is no positive form. To find that form, a step in the right direction might be to break the association between the random and the unreasonable. By way of comparison we recognise that there is such a thing as righteous anger, and that divine wrath is the inevitable reaction of a good God to moral evil and is not incompatible with divine love. It may be that we will have to take a long hard look at what randomness really is, and to make room for it in our understanding of the nature of God.

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