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CONSCIOUSNESS OR THE PHYSICAL UNIVERSE – WHICH CAME FIRST?

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Historically, many have seen the intelligibility of the physical universe as showing that it is somehow ultimately dependent upon conscious intelligent pre-existing being – ‘God’. Today, however, many believe that modern advances in our scientific understanding of the origins and nature of the universe, and of the conscious intelligent beings it contains, render God, as Laplace said, an ‘unnecessary hypothesis’. This article considers whether the findings of modern science do indeed diminish the plausibility of belief in a creator God. Or, on the contrary, whether there are features of current scientific understanding which may reasonably be thought to support the belief that conscious intelligent being pre-existed the physical universe and caused it to be. In short: can science reasonably be thought to support the view that consciousness created the physical universe rather than that the physical universe created consciousness?

I. HOW THE QUESTION ARISES TODAY

The physical origin of the universe

As is well known, scientific theory supported by empirical observation currently paints the following broad cosmological picture.

Our observable universe, space and time, came into being from nothing material via a ‘Big Bang’ some 13.7 billion years ago. Immediately after the Big Bang the entire primordial content of the universe was intensely dense and hot. But almost immediately (in a process known as ‘inflation’) it expanded for a split second at an immense speed, cooling and becoming less dense. It has continued to expand, more slowly, ever since and is thought now to be destined in the distant future to accelerate exponentially to ultimate destruction. The Big Bang generated and energised the particles of matter which very soon formed the hydrogen and helium nuclei[1] which, in time,[2] became atoms – basic constituents of stars clustered into galaxies. There are perhaps hundreds of billions of galaxies, each galaxy itself containing hundreds of billions of stars and measuring hundreds of thousands of light years across.

Matter and the forces which act upon it (gravity, electro-magnetism and the strong and weak nuclear forces, together with the recently-discovered and little-understood expansion force of ‘dark energy’) behave uniformly in space and in time throughout the observable universe. This uniformity is described in terms of there being ‘laws of nature’ which govern not only everything which has occurred since the Big Bang but were themselves somehow responsible for generating the Big Bang.

How life emerged in a previously wholly inorganic universe remains a mystery. But what is now clear is that the inorganic environment had features which made it peculiarly suitable for life to emerge. An issue which continues to polarise opinion is whether one can usefully ask the question why the inorganic universe is, in Paul Davies' words,[3] 'just right for life'. Is the emergence of life and the evolution of conscious beings of any special significance or is it to be seen as simply another outcome of the operation of the physical laws just referred to? In particular, is there any special significance in the fact that there are intelligent beings in the universe who can understand ever more about how the universe came to be as it is, and about how they came to be part of it? Also, does life – including intelligent life – exist elsewhere than on Earth? Current indications are that it does – and in great abundance. For even in our own Milky Way galaxy of at least 100 billion sun-like stars, there are, according to recent estimates, some 20 billion Earth-size planets many of which may be suitable for life. And there are at least 100 billion galaxies in an observable universe governed by uniform physical laws. The chances seem small that in these circumstances intelligent life has evolved only on our tiny globe.

Cosmologists do, of course, acknowledge that questions arise as to how the universe came into being 'from nothing'. Since time, like space, began to exist only immediately after the Big Bang, it makes no sense to ask 'what happened before the Big Bang?' For there was no time for anything to happen in. Yet it does make sense to ask what caused the Big Bang and the physical laws and forces which generated it. Broadly, there are two possible types of answer. Either there was a natural propensity for the event to occur, or the cause of the event was supernatural. If it was a natural propensity, there is no logical necessity to do more than describe it. There is no logical basis for insisting that there must be a cause of the natural propensity any more than that there must be a cause of a supernatural cause. So, for example, some scientists describe the natural propensity which they believe caused the Big Bang as a 'singularity'. This is essentially the conclusion of a mathematical projection back from what is known about the operation of laws and forces in the very early universe to a point of 'infinite curve and density'[4] beyond which further projection is impossible. Logically, the singularity may simply have existed: it may simply be the uncaused cause of the Big Bang and all that followed. But, equally, it may be the creation of pre-existing conscious being.

Why might conscious being be thought to have created the physical universe?

Suppose that the laws and the forces which caused the Big Bang simply exist as 'brute facts'. Suppose too, for the moment, that the observable universe is all that there is.[5] On this basis, we are invited by materialists to believe that the laws and the forces which govern the universe 'just happened' to be as they are and 'just happened' to cause life to emerge from inorganic matter. Of course, Richard Dawkins[6] and others have explained that the evolution of life from its primitive beginnings cannot be said likewise to have 'just happened'. For the driving force of organic evolution is natural selection – the natural propensity of those organisms which are best adapted to survive and reproduce in the environment in which they find themselves to survive best and to reproduce best in that environment. This is said to be the answer to Paley's[7] 'watchmaker' argument – the argument that a complex and well-designed organism such as *homo sapiens*, like a complex and well-designed machine, implies an intelligent and purposive designer.

But there is no process of natural selection in the inorganic world. Natural selection may be able to explain why birds have wings and many creatures have eyes. But it has no application to the question of why the laws and forces which govern, and have governed, inorganic matter are as they are – producing the complex, intelligible universe which we observe and, in particular, the organic life from which intelligent beings have evolved. And many continue to believe that this complexity and intelligibility are the product of pre-existing conscious intelligent being rather than of a cosmic lottery governed by pure chance. The question is, then, whether current scientific understanding of the physical universe may reasonably be thought to support such belief or, on the contrary, does it suggest that things are as they are simply because they happen to be so, or for some other reason?

II. 'FINE TUNING' IN THE UNIVERSE

Laws, Values and Interactions

Scientific laws are general statements of relationships between physical phenomena. Newton's law of gravity, for example, states that the force of gravitational attraction exerted by one object upon another is proportionate to their respective masses, and varies inversely to the square of the distance between them: if the distance between the objects doubles, the force diminishes fourfold. The electromagnetic attraction or repulsion between two objects varies in like fashion.

Such laws by themselves tell us nothing about the strength of the force in question in any specific case. To discover this, we have to insert values (or 'numbers') into the equations. These values can be obtained only by empirical observation – by measurement. So, if we measure the gravitational or the electromagnetic force which exists between two objects of known mass at a given distance, we can then use the inverse square law to calculate what that force will be if the distance subsequently changes.

As will appear below, the actual strengths of forces such as gravity and electromagnetism are among a relatively small number of values critical to the configuration of the physical universe. If they were significantly different from what they are, the universe would demonstrably be a very different place from what it is. In particular, many of the features which allow life to emerge and to evolve would be absent. And it is not the values of particular forces alone which account for things being as they are. It is also the relationships – the numerical ratios – between the strengths of different forces. For example, as we shall see, it can be shown that there are features of the universe critical to the existence of life which depend precisely upon the ratio between the strengths of the gravitational and electromagnetic forces being as it is.

For present purposes the central point is this: it is not understood why the values which are observed and which, taken together, produce an environment suitable for the emergence and evolution of life forms, are what they are. They are not, so to say, dictated by theory. So far as is currently understood, they just happen to be as they are. These so-called 'free parameters' could, theoretically, be different; and if they were, life as it is could not exist. But they are not, and it does.

This is what is meant when it is said that the universe is 'fine-tuned' (or 'just right') for life to emerge. But two crucial points must be made at once: first, the statement just made that the free parameters could, theoretically, be different is true as far as current theory goes. It is obviously also true that in the future some new unifying theory may emerge which shows that the parameters are not in this sense 'free' but, on the contrary, could not be otherwise. This issue will be pursued in section IV, below. The second point is that to speak of 'fine tuning' does not necessarily imply that there is a conscious fine-tuner. This article is concerned precisely with the question whether or not there is a basis for believing that there is such a conscious fine-tuner or universe designer. At present our concern is simply to give some examples of the phenomenon of fine tuning of numbers and ratios.

Examples of fine tuning – why there can be stars and planets – the cosmic numbers 'Q', 'N' and 'λ'

Planets such as Earth, with an environment suitable for the emergence and evolution of life, orbit sun-like stars in 'solar systems'. One finely-tuned number and two force ratios of the kind mentioned above are critical to the existence of stars and planets

- The primordial matter in the early universe consisted of 'a plasma of freely-moving atomic components – protons, neutrons and electrons'.[8] The density of these microscopic quantum particles[9] fluctuates continuously. The extent of these quantum density fluctuations is very small (about 1 in 100,000 or 10^{-5} and denoted by the letter 'Q'[10]). It is thought that during the split second of extremely rapid 'inflation' immediately after the Big Bang these small fluctuations were manifested as more and less dense areas of the embryo universe. Under the stronger gravitational force exerted by the denser areas the record of these fluctuations became writ ever larger in the expanding universe, those denser areas appearing as the 'ripples' (galaxy seeds) observable on the famous 2003 WMAP picture of the universe as it was at about 380,000 years after the Big Bang. As Martin Rees observes in *Just Six Numbers*:[11]

  > The fabric of our universe depends on [the] number Q. If Q were . . . smaller, the universe would be inert and structureless; if Q were much larger, it would be a violent place, in which no stars or solar systems could survive, dominated by vast black holes.

  The number Q is, then, itself finely-tuned in the sense that Q is as it needs to be for the development of an environment (galaxies containing solar systems) in which life is possible. But the efficacy of Q in turn depends upon a further piece of fine tuning – the ratio between the strengths of the forces of gravity and electromagnetism. For it is this ratio which determines the environment within which Q has the effects above described. If the ratio – and so the environment – were different, Q would not have the effects which it does. How is this the case?

  Electromagnetism operates within atoms to maintain their structure – the positively charged nucleus orbited by negatively charged electrons. Electromagnetism is hugely stronger than gravity: about 10^{36} times – a ratio denoted by the letter 'N'. This disparity is counter-intuitive: we experience gravity as strongly as we do because its force is cumulative: the more matter there is, the stronger is its gravity; whereas the net force of electromagnetism is much reduced by the interaction of positive and negative charges, 'so gravity "gains" relative to electrical forces in larger objects'.[12] The attractive effect of gravity at atomic level is thus completely overwhelmed by the effect of electromagnetism. But at larger scales, gravity is felt ever more powerfully. It is N, the 10^{36} ratio, which determines the relative effects of the two forces at all levels – and which, thus, determines many critical features of the observable universe, including the size, thermal properties and life-span of stars and their planets – and thus the time available for organic evolution.[13] It is N also – expressing the weakness of gravity relative to electromagnetism – which is critical in determining the effect of Q – the continuous fluctuations of the density of the elementary, quantum, constituents of matter. Were gravity stronger, the galaxy-seeding effect of Q (described above) would have been fatally compromised.[14]

  In short, then: the number Q is as it needs to be to produce a universe in which life is possible. But Q has the effect it does because the ratio N is as it is, governing the interaction of gravity and electromagnetism at the atomic level at which Q operates. If Q is the seed, N is the soil in which it flourishes.

- Also critical to the existence of a universe containing planets hospitable to life is the relationship of gravity to another force whose strength has only recently been ascertained.

Einstein at first believed that the universe was held at a constant size by an expansionary (anti-gravitational) force whose strength was just right to prevent gravity from causing the universe to collapse under its own weight. He later acknowledged that Hubble's observations in the 1920s indicated that the universe was not static, but expanding – albeit at an ever-decreasing rate. But in 1998, using data from the Hubble Space Telescope, it was discovered from observation of very distant supernovas (explosions as massive stars collapse)[15] that the rate at which the universe is expanding is in fact increasing rather than decreasing. The expansionary force responsible for this increasing rate of expansion is referred to as 'dark energy' and may be thought of as a kind of negative pressure, or tension, in inter-galactic space. Its nature (like that of 'dark matter' which, apparently, far exceeds 'ordinary' matter in both mass and, therefore, gravitational effect[16]) is not yet understood. But measurements have shown that, relative to the strength of gravity, the strength of dark energy (a value denoted by the Greek letter 'λ') is very low, thus enabling the formation of galaxies and their continuing existence for a period long enough for life to emerge and evolve as it has. But Davies points out[17] that:

> [I]f the magnitude of the dark energy were only moderately larger than the observed value, it would have frustrated the formation of galaxies.... So our existence depends on dark energy not being too large.

More fine tuning – the story of the element carbon

Because it occurs in all living tissue and readily combines with other elements critical for life-formation, carbon is often said to be the key life-giving element. Both its emergence and its dissemination are processes which display a high degree of fine tuning.

- As will be explained below, carbon is made in stars by the fusion of helium nuclei. The fuel for this nuclear fusion process is hydrogen. The amount of carbon in the universe thus depends upon the proportion of hydrogen, the fuel for its manufacture, to helium, its raw material. This proportion, established during the period of nuclear fusion of hydrogen into helium in the first few minutes after the Big Bang, is 75:25 in favour of hydrogen – a proportion which gives just enough helium for the manufacture of the amount of carbon which has been sufficient for the emergence of life, and just enough hydrogen both for the nuclear fusion in stars which has produced that amount of carbon and for the making, with oxygen, of life-grounding water.

  It is now understood[18] that this critical hydrogen-to-helium ratio itself depends upon the finely-tuned strength of the weak nuclear force which operates within atomic nuclei to transmute protons into neutrons and vice versa. In the few minutes of nuclear fusion shortly after the Big Bang the weak nuclear force transmuted unstable primordial neutrons into protons (hydrogen nuclei). But some of these neutrons escaped transmutation by combining with protons to form stable helium nuclei. Had the weak nuclear force been stronger than it is (transmuting neutrons more quickly), less helium and more hydrogen would have resulted; vice versa had it been weaker. Either way, 'the chemical make-up of the universe would be very different, and with much poorer prospects for life.'[19]
- Only hydrogen and helium nuclei (and trace amounts of deuterium and lithium) emerged from the period of nuclear fusion in the first few minutes after the Big Bang. Carbon and almost all of the other elements found in nature are created by nuclear fusion in star cores. In this process protons collide at high speed and are forced and held together by

the strong nuclear force which overcomes the protons' electrical repulsion. But carbon is unique among the elements in the following way. The strong nuclear force causes the single-proton nuclei of hydrogen to fuse readily to produce helium nuclei: 2-proton, 2-neutron 'alpha particles'. But when two of these helium nuclei collide at fusion temperatures what is produced is an unstable isotope of beryllium which, without more, would decay (under the protons' electrical repulsion) before a third helium nucleus could collide with it to produce a stable (6-proton, 6-neutron, 'triple alpha') carbon nucleus. In stellar nuclear fusion this decay is in fact delayed long enough for carbon to be formed by the addition of a third helium nucleus. The delay is caused by a momentary surge of energy in the beryllium nucleus generated by so-called 'quantum resonance'. At fusion temperatures this is a continual process of rapid increase in the frequency of quantum density fluctuation[20] to a high point (or 'spike') followed by an immediate, equally rapid, decrease. The level of this resonance is determined by the strength of the strong nuclear force relative to the electromagnetic repulsion between colliding protons.

As Davies says:[21] 'If the strong force were slightly stronger or slightly weaker (by maybe as little as 1 per cent), then the binding energies of the nuclei would change', the 'triple alpha process' of carbon production could not occur and life could not exist in our universe. Fred Hoyle, who in the early 1950s calculated the level of the resonance, famously observed that this unlikely degree of precision in the interaction between the strong nuclear and electromagnetic forces during nuclear fusion made the appearance of carbon look like a 'put-up job'.

- As noted above, the strength of the weak nuclear force was critical in producing the 75:25 hydrogen/helium ratio upon which the amount of both carbon and hydrogen, and so the existence of life in the universe, ultimately depends. As will now be explained, it is critical also in facilitating the dissemination of carbon and its appearance on earth (and in other life-friendly environments).

  When a star's supply of hydrogen becomes insufficient for nuclear fusion, the star collapses and may then explode producing a short-lived, intensely bright 'supernova'. In the collapse, material is violently compressed and the weak nuclear force causes protons to transmute into neutrons, thereby releasing particles called neutrinos. These neutrinos are emitted from the supernova in high-pressure streams which create a pathway for the passage of carbon and other heavy elements into space. This functioning of the neutrino streams results directly from the finely-tuned strength of the weak nuclear force. If the weak force were weaker, the neutrinos would lack the strength to create the pathway; if stronger, they would react with other particles in the stellar core and would not be emitted into space. 'Either way, the dissemination of carbon and other heavy elements needed for life . . . would be compromised.'[22]

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It is evident that the existence of life as we know it depends upon features of the observable universe which themselves depend upon the strengths of and ratios between the five known forces: gravity, dark energy, electromagnetism and the strong and weak nuclear forces. The observed values of these strengths and ratios cannot, at present, be explained by reference to any theory. Yet, were any one or more of these values significantly different – less finely-tuned – the universe would not be intelligible as it is, nor would it contain intelligent observers to whom its intelligibility is apparent.

Section IV below will consider the relevance of fine tuning to the question whether the findings of modern science may reasonably be thought to support the belief that conscious intelligent being pre-existed and caused the universe to be. But first it is necessary to say something about a different kind of fine tuning.

III. THE 'QUANTUM TO CLASSICAL' PHENOMENON – TUNING TO THE PERCEPTIONS OF CONSCIOUS BEINGS

The point to be made here is essentially this. The fundamental – 'quantum' – constituents of matter do not behave in the clear and predictable manner in which, at everyday level, we perceive matter to behave. Yet they do behave in a manner which produces the clear and predictable behaviour which we conscious beings perceive. It will be suggested that this can be seen as a kind of fine tuning which is no less remarkable than that dealt with above.

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At the level of our everyday perception, matter behaves as described by the laws of Newtonian (or 'classical') physics. Essentially, we see any given material object as being located in one particular place at one particular time: it is now here or it is there. And, generally, we can make firm and accurate predictions about where it will be in the immediate future: it behaves deterministically.

It is now well-established that this clear and reliable material world of our everyday perception is not the material world which we will see if we very greatly magnify the material object which we are looking at. The atoms of which all matter is composed are almost unimaginably small, but the fundamental 'quantum' particles of which atoms themselves are made 'are at least 100 million times smaller than the atoms'.[23] The nuclei of atoms consist of protons and (the single-proton hydrogen nucleus apart) neutrons, both of which are themselves made up of a type of these fundamental particles called quarks. The atomic nucleus is orbited by a different type of fundamental particle, the electron. These fundamental constituents of matter do not behave clearly and deterministically according to Newtonian principles; instead, they behave in a manner which the Nobel prize-winning physicist Richard Feynman described as uncertain and probabilistic.[24]

The uncertainty is exemplified by the characteristic of quantum particles that they exist ordinarily in a state of 'superposition' – they are, at any given moment, neither exclusively here nor exclusively there: they are, although indivisible, to some extent both here and there. The notion of superposition is dramatically illustrated by the so-called 'double slits experiment'.[25] In this experiment, a stream of electrons is fired towards a screen in which there are two well-separated slits through which the electrons can pass. Some distance beyond the slit screen is a detector screen which records the impact of those electrons which have passed through the slit screen. Since electrons are indivisible, one would expect that each electron which passes through the screen would pass through one slit or the other. And if a detector is placed very near each slit, then this is indeed what is observed. But if the electrons are left unobserved until they hit the more distant detector screen, the record of their impact shows that each indivisible electron passes through both slits. As John Polkinghorne has remarked: 'In terms of classical intuition this is a nonsense conclusion. In terms of quantum theory's superposition principle, however, it makes perfect sense.'[26]

The superpositional character of matter at its fundamental level reflects the fact that at this level it behaves not only like a particle but also like a wave. It is a feature of this 'wave-particle duality' that if one measures[27] precisely, eg, the (particle-like) position of a quantum entity at a particular moment one cannot simultaneously precisely measure its (wave-like) momentum or any other variable property of the quantum particle, such as its spin. The more precisely its position (say) is identified, the less precisely can one simultaneously identify its other variable properties; and complete certainty as to one variable necessarily goes with maximum uncertainty as to others. This is Heisenberg's 'uncertainty principle' which yields the following further profound contrast between quantum and classical behaviour of matter. A particular feature of classical behaviour is the so-called 'arrow of time': at classical level the behaviour of matter is perceived within an irreversible time sequence. There is no such perception at quantum level: '[the] film would make equal sense if it were run forwards or backwards.'[28]

The behaviour of matter at this fundamental microscopic ('micro') level is non-classical also in that it is probabilistic rather than deterministic. At a certain level of largeness (perhaps the size of larger molecules such as DNA and above) most groupings of quantum particles behave predictably, according to Newton's laws, when observed at everyday, macroscopic ('macro'), level. In contrast, at micro levels matter behaves unpredictably. This unpredictability is confined within certain limits: the range of probable behaviour of a given quantum entity (its 'probability amplitudes') is expressed by the so-called Schrödinger equation. It is important to stress that the unpredictability of quantum behaviour is held to be what one may call 'true' or 'real' unpredictability. In the world of classical physics, if an outcome is unpredictable (eg like the toss of a coin or throw of dice) it is so because we do not have enough information about all the relevant circumstances governing the outcome; but the behaviour of a quantum particle is unpredictable because its developing course is generally held[29] to be not governed by cause and effect, but to be (within the relevant probability amplitudes) a matter of pure chance.

The 'quantum to classical' problem

If quantum behaviour is, as Feynman often insisted, mysterious, it is also something of a mystery that matter behaves classically when observed and experienced at everyday level. For consider:

- Matter is made up entirely of quantum entities ('wave-particles') which always and everywhere behave non-classically. For it is emphatically *not* the case that groupings of quantum particles above a certain size *cease* to behave in a quantum fashion and *instead* behave classically.
- In fact, if one 'zooms-in' sufficiently closely on *any* matter – a pool of water, a chunk of rock, a piece of flesh – what one will see is, exclusively, quantum behaviour. That this is so is attested by empirical evidence of the most compelling and unequivocal kind.
- For as Feynman has written: '[quantum] theory describes all the phenomena of the physical world [he instances 'gasoline burning in automobiles, foam and bubbles, the hardness of salt or copper, the stiffness of steel'] except the gravitational effect ... and radioactive phenomena'.[30] And the theory matches observation to an extraordinarily high degree. For example, experimental measurement of the magnetic force of an electron matches the predictions of quantum theory to an accuracy of a human hair's thickness in the distance from Los Angeles to New York.[31] By comparison, the predictions of Newtonian theory correspond with experimental observation only approximately.
- In other words, the behaviour of matter which we observe as clear and deterministic at macro level is far more accurately described by observation at micro level which shows it to be unclear and probabilistic.
- Nevertheless, at everyday level this continuing quantum behaviour is unnoticeable. As observed above, quantum entities are at least 100 million times smaller than atoms. Because of the scale of things, we do not observe quantum behaviour at everyday, macro, level. We observe, as it were, its opposite: uncertainty and probability at micro level translate into clear and deterministic behaviour at everyday level.

How can this be the case?

It is not fully understood how the quantum behaviour of elementary particles can give rise to 'classical' behaviour in large systems – ie, 'how it can be', as Polkinghorne says, 'that the quantum constituents of the physical world, such as quarks and . . . electrons, whose behaviour is cloudy and fitful, can give rise to the macroscopic world of everyday experience, which seems so clear and reliable'.[32]

It is, however, known[33] that background radiation in the environment contributes significantly to the emergence of classical behaviour through a process known as quantum decoherence which Polkinghorne defines as 'an environmental effect on quantum systems that is capable of rapidly inducing almost classical behaviour'.[34] This is part, but evidently not the whole, of the explanation. So a problem remains.

One possible route to a solution is as follows. Laboratory observation of a quantum particle can momentarily measure and record its precise position (or its momentum, or whatever other variable property of the quantum particle, eg spin, is measured) as if it were a 'classical' particle – though immediately after the measurement is made the position (or other measured variable) changes and becomes once again uncertain. This measurement process thus records a momentary 'classicality' of position (or other measured variable) of the measured particle – a momentarily fixed, knowable state (an 'eigenstate'). The so-called 'Copenhagen interpretation' of quantum mechanics postulates that this momentary appearance of classicality is somehow induced by the largeness and complexity of the measuring apparatus. Extrapolating from this, it seems possible that it is the size and complexity of large and complex systems themselves which somehow accounts for their sustained classical behaviour as observed at everyday macro level.

Thus, while quantum particles do not behave classically, they routinely and predictably group themselves into large systems which, when observed at everyday level, do behave classically. There is a body of theory which predicts *that* this routine grouping with its attendant classical behaviour will occur as we perceive it to do. But *how* this classical, deterministic, behaviour of large quantum systems arises is not fully understood. Nevertheless, in so far as it does routinely arise in accordance with theory, its occurrence may be seen as a case of cause (large groupings of quantum entities) and effect (classical behaviour of those groupings when observed at everyday level). In this sense one may say that *the deterministic behaviour of matter at everyday level is predetermined to emerge from the non-deterministic behaviour of its quantum constituents*.

It is suggested that the fact that at everyday level matter behaves clearly and predictably whereas fundamentally its behaviour is uncertain and probabilistic can be seen as a kind of fine tuning. What we may label 'quantum-to-classical' fine tuning is a different kind from that dealt with above – the action and interaction of particles and forces which has, improbably, led to the appearance of life and the evolution of conscious intelligent beings. The emergence of classical from quantum behaviour of matter is 'fine tuning' in the sense that it allows the conscious intelligent beings who have evolved to perceive, and in some measure to understand, the observable universe. In short, it allows the physical world to be perceived as intelligible by intelligent beings.

IV. FINE TUNING AS EVIDENCE OF CONSCIOUS CREATION

How does our universe come to be finely-tuned?

This question requires a sharp focus. As the starting point of this 'how?' enquiry, take the notion, mentioned above, of a 'singularity' – a physical propensity for a 'Big Bang' to occur. For the moment, do not ask 'how does that propensity come to be?' Ask instead how life emerges from the Big Bang and its aftermath. Leave aside the awkward fact that scientists have not yet been able to explain how life emerges from inorganic matter. Assume for the purposes of the discussion what is highly probable – that scientists will sooner or later discover this. So, take it that we have a physical propensity for a Big Bang to occur; and assume that we can describe more or less the physical processes which lead from Big Bang to the emergence of life; and that the theory of evolution by random mutation and natural selection explains how primitive life develops over time into highly complex life forms including conscious intelligent beings. In this context, what is the 'how?' question asking? Can we not simply say that the above analysis explains how our universe comes to be as it is and to contain conscious intelligent beings who can understand these things?

A difficulty which many find with this answer is its apparent treatment of the examples of fine tuning described in the previous two sections as simply an assemblage of fortuitous cosmic facts which, neither singly nor collectively, call for any special explanation. But chance does not seem to operate in this way.[35] If one week someone wins the National Lottery jackpot on the purchase of a single ticket, one will no doubt attribute the success to chance. If that person enjoys the same success each week for many weeks, one will certainly attribute that to the intervention of some conscious agent. Experience tells us that chance does not produce such a sequence. On a similar basis, it may fairly be said that the burden of offering some explanation, other than chance, of fine tuning in the universe lies upon those who decline to attribute it ultimately to the intervention of some conscious agent – to the deliberate action of pre-existing conscious intelligent being. Such, certainly, was the view of the authorities in the Soviet Union who discouraged work on the question of why the universe is fine-tuned for the emergence of life – for, as Davies says, '[i]t was an embarrassment – it looked too much like the work of a Cosmic Designer'.[36]

If, then, the choice for explaining fine tuning is between chance and conscious intelligent pre-existing being – 'God' – many feel (some reluctantly) that God wins. But an alternative approach is to postulate that fine tuning can be wholly and satisfactorily explained by purely physical processes. Two very different varieties of such approach will now be considered.

- One way of explaining away the appearance of conscious fine tuning is to argue that this appearance merely reflects the fact that current theoretical understanding of the observable universe is, so to say, 'piece-meal'. For, it is said, scientists may sooner or later discover an adequate 'theory of everything': a theory which will show how all current observationally-supported theories are simply constituents of a single over-arching theory which will explain why all observed values and ratios are necessarily as they are.

  Such a theory would show us that things – including what we currently see as finely-tuned particular values and ratios – could not, scientifically speaking, be otherwise than they are. In the context of this hypothetical comprehensive theory, the value of the quantum resonance spike which explains how carbon came to be made would no longer seem to be a 'put-up job'; and the critical ratios of the forces of gravity and electromagnetism, or of gravity and dark energy, would no longer appear inexplicably, suspiciously, like the temperature of Baby Bear's porridge, 'just right' for life. All would follow from this over-arching theory of everything.

  But, of course, the question would remain of how the universe came to be governed by such a theory. The theory would show that the physical characteristics of the universe which we now see as fine tuning could not indeed be other than they are. But one would still be entitled to ask 'why *this* universe, explicable by *this* theory? Why not another universe and another theory? Or why not no universe at all?' In terms of answering the 'fine tuning' question, the discovery of a 'theory of everything' of this sort simply brings us back to a choice between regarding it either as a brute fact – a fortuitous ‘given’ – or as the work of God.

But there is another quite different type of ‘ultimate theory’ which must now be considered.

- Many cosmologists[37] today think that what appears to be fine tuning is actually an illusion induced by a sort of cosmological myopia. They conjecture that our observable universe is in fact only one, so-called ‘pocket’, universe in a cosmos which contains countless billions of such pocket universes. The cosmos is thus a ‘multiverse’. Only some, perhaps a very few, pocket universes will turn out by chance to have the physical characteristics required for sustaining life and evolving intelligent observers. Since, *ex hypothesi*, those few pocket universes will be ‘just right’ for sustaining life and evolving intelligent observers, the fact that they are and have done so requires no special explanation. What seems from our extremely limited perspective to be extraordinarily fine tuning is, in the vastly wider perspective of the multiverse, no more than the inexorable operation of chance – just as a very few players will beat the huge odds against winning the lottery jackpot.

  The basis of multiverse theory (there are a number of different versions) is the application of Heisenberg’s quantum uncertainty principle[38] to current thinking about the very early universe, in particular the split second of ‘inflation’ immediately following the Big Bang. Briefly, the primordial quantum flux is regarded as inherently inflationary. Inflation manifests a, perhaps eternally, recurring cycle of uncertainty of the variables in the behaviour of quantum entities. Each pocket universe is the product of one single episode[39] of ‘Big Bang’ inflation among billions; it has been calculated (by reference to the possible range of outcomes contained within quantum probability amplitudes) that the number of such pocket universes is likely vastly to exceed the number of atoms in our own pocket universe.[40] And each pocket universe develops differently from the others. As in each episode of inflation the quantum vacuum expands and cools, its primordial ‘symmetries’ are broken in different ways and with different outcomes (‘domain structures’) in and between the forces operating within each pocket universe.[41] Given the unimaginably large number of possible pocket universes, it is entirely unsurprising that ours will exist, with its apparently fine-tuned, but actually random, parameters which make it ‘just right for life’.

  Since, on this approach, our observable universe is the only pocket universe which we can observe, it is immediately evident that the notion of empirical verification of multiverse theory presents formidable difficulties. Certainly, at present, the epistemological status of the theory is nearer to theology than to science.

Conclusion: cosmology and religion today

Rees summarises the position as follows:

> If the underlying laws determine all the key numbers uniquely, so that no other universe is mathematically consistent with those laws, then we would have to accept that the ‘tuning’ was [either] a brute fact, or providence. On the other hand, the ultimate theory might permit a multiverse whose evolution is punctuated by repeated Big Bangs; the underlying physical laws, applying throughout the multiverse, may then permit diversity in the individual universes.[42]

Briefly, then: unless fine tuning is simply how things chance to be (‘brute fact’), it reflects either the working of ‘providence’ or the fact that our vast observable universe is just one of billions of pocket universes comprising a multiverse. More briefly still: it seems that to explain fine tuning we must back either chance, or God, or a multiverse.[43]

This article asks whether there are features of current scientific understanding of the physical universe – in particular of its suitability for the emergence of life, and for the evolution of intelligent beings – which may reasonably be thought to support the belief that the universe is the product of consciousness rather than the reverse. That this belief today offers one of the three widely-held alternative rational[44] explanations of fine tuning is surely enough to warrant an affirmative answer to the question. In itself, clearly, the belief that the universe is the product of consciousness raises, but does not begin to answer, numerous and varied questions regarding the origin and nature of this 'consciousness'. But clearly too, one line of answers to these questions leads to monotheism. So, for Christians and others, this view of fine tuning can offer a way of reconciling the findings of modern science with the foundations, at any rate, of their religious belief. For if science and religion are equally concerned in the search for truth they must be reconciled.

To be sure, things may look different in the future, as scientific understanding develops. If multiverse thinking becomes scientific orthodoxy, our perspective upon what we now call fine tuning will change, along with both scientific and religious understandings. But for now:

> It may be frustrating to acknowledge, but we are simply at the point in the history of human thought at which we find ourselves, and our successors will make discoveries and develop forms of understanding of which we have not dreamt. Humans are addicted to the hope for a final reckoning, but intellectual humility requires that we resist the temptation to assume that tools of the kind we now have are in principle sufficient to understand the universe as a whole.[45]

Notes

1 See *The story of the element carbon* in section II, below.
2 Around 400,000 years after the Big Bang the universe had cooled sufficiently for protons to capture electrons, so allowing the formation of atoms.
3 *The Goldilocks Enigma – Why is the Universe Just Right for Life?* (London: Penguin Books, 2007; hereafter, *GE*).
4 *GE,* p. 79.
5 Many scientists believe, on the contrary, that the observable universe is only an infinitesimal part of a 'multiverse' (see section IV below).
6 *The Blind Watchmaker* (London: Longman, 1986).
7 William Paley, *Natural Theology* (1802).
8 *GE,* p. 57.
9 The nature of quantum particles is explored below in section III, THE 'QUANTUM TO CLASSICAL' PHENOMENON.
10 *GE,* p. 165.
11 (London: Phoenix, 2000) at p. 3. For detail, see ch. 8.
12 Rees, *ibid*. p. 31; see also, *GE,* p. 163.
13 Rees, *ibid*. ch. 3. See also, *GE,* pp. 163-4.
14 Max Tegmark and Martin Rees, 'Why Is the Cosmic Microwave Background Fluctuation Level 10^{-5}?', *Astrophysical Journal*, June 1998.
15 See further below.
16 Rees, *Just Six Numbers*, ch. 6. (It is calculated that dark energy and dark matter together make up around 96% of the mass of the observable universe. The remaining 4% is the mass of 'ordinary' matter: *GE,* p. 139.)
17 *GE,* p. 170.
18 *GE,* pp. 161-2.
19 *Ibid*.
20 See above.
21 *GE,* p. 157.
22 *GE,* p. 160.

23 Polkinghorne, *Quantum Theory, a Very Short Introduction* (Oxford: Oxford University Press, 2002), p. 39.
24 Feynman, *The Character of Physical Law,* (Cambridge, USA: MIT Press, 1965), ch 6.
25 Described with pellucid clarity by Feynman, *ibid*.
26 *Op. cit*. p. 24.
27 On this momentary measurement of a variable property of a quantum particle such as its position, see further below.
28 Polkinghorne, *op. cit*., p. 49; Rees, *Just Six Numbers*, p. 152.
29 David Bohm's theory of quantum determinism has not found wide support in the scientific community.
30 Feynman, *QED: The Strange Theory of Light and Matter* (London: Penguin Books, 1992), Introduction.
31 *Ibid*.
32 Polkinghorne, *op. cit*., p. 43.
33 *Ibid*.
34 *Op. cit*., p. 96. Research into this phenomenon has been active since the 1980s.
35 But cf below, 'multiverse' theory.
36 *GE,* p. 172.
37 Davies says 'a growing minority' (*GE*, p. 298).
38 For this, and quantum theory generally, see III above.
39 Rees, *Just Six Numbers*, p. 147.
40 10^{500} pocket universes compared with a mere 10^{80} atoms in our observable universe (*GE*, p. 192).
41 *Ibid*. pp. 184-5, *passim*.
42 Rees, *loc cit*, p. 174.
43 In *GE*, ch. 10, Davies explores a possible third scientific approach (alternative to chance and multiverse) based essentially on the lack of an 'arrow of time' in quantum theory. This may allow 'later' (in 'classical' terms) events to influence 'earlier' ones. In this way, he suggests, the universe may come to be understood as a closed system or 'causal loop' which requires no explanation of its existence or intelligibility other than that it exists and is intelligible.
44 Davies, *GE*, p. 225.
45 Thomas Nagel, *Mind and Cosmos: Why the Materialist Neo-Darwinian Conception of Nature is Almost Certainly False* (Oxford: Oxford University Press, 2012), p. 3. Like Davies, Nagel argues that we should seek a natural, not a supernatural, explanation of the intelligibility of the universe. But, unlike Davies, Nagel suggests (p. 32, *passim*) that the natural explanation will turn out to be not wholly materialistic but will take account of the fundamentally 'physical and . . . mental character of the universe' (p. 69).