Conscious Existence, Cosmology and the Meaning of Life

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The Existential Dilemma

Conscious beings are launched by their very existence on a quest to discover the essential meaning in life that makes sense of the entire process. It's the one thing we all want to know - the central core truth of reality - before we escape the mortal coil and pass on.

There are many depictions of the existential dilemma, echoing through philosophy, novels, art music and theatre. Existentialism itself is an attempt to form a philosophy centered on this dilemma, emphasizing the existence of the individual person, as a free and responsible agent, determining their own development, through acts of the will. Jean Paul Sartre claimed that a central proposition of Existentialism is that existence precedes essence, which means that the most important consideration for individuals is that they are individuals - independently acting and responsible, conscious beings (existence) - rather than what labels, roles, or other preconceived categories the individuals fit (essence). Thus, human beings, through their own consciousness, create their own values and determine a meaning to their life.

Many religious people believe in an ordered cosmos ruled by God, with the single purpose of testing human moral obedience in a cosmological trial ending in a day of judgment. All the great monotheistic religions preach that we must obey God's commands if we seek eternal life in heaven and that those who fall into sin will be tormented forever in the fires of hell. Nor do we have the right to even assess whether these claims are true or false, for such religion also demands that we believe, regardless of the evidence or lack of it, either as the foundation of affirmative religious faith, or oppressively as in Islam, under pain of death for apostasy. Centrally this is a moral cosmology in which conscious experience is predominant in fantastic visions of paradise and hell taking precedence over the veridical reality of nature and the real world around us.

Doctrines claiming the literal truth of every word in the Bible and Quran lead to an inability to accept the evidence of the natural and physical world. Rejecting the clear evidence that the universe, the Earth and life itself are billions of years old, many cling to the notion that the universe was made literally in six days, as in the sabbatical creation, so is no older than the 4000 years ago, when the events of Genesis are assumed to have occurred. Those Christians whose scientific experience leads them to have to acknowledge the evidence of the universe's actual age, unable to escape the convictions of their religious beliefs, attempt to paste the literal 'revealed truth' of the scripture into the scientific view, so that the same literal Old Testament deity has instead made the vast ancient physical universe, we have discovered much later in the scientific age, but then claim has much more recently, manifested again to 'give' human kind the knowledge of good and evil and 'living souls', so that we still have to live out the morally imperative eschatology regardless.

Others of a more honest predisposition may conclude there is no preferential rhyme or reason to existence in the physical world and that life is, just as we see it, a round of tooth and claw, as generation upon generation struggles in the survival of the fittest, amid the endless attrition of entropy and mutational change, most ominously and succinctly expressed by Bertrand Russell:

Such in outline, but even more purposeless, more devoid of meaning is the world which science presents for our belief. Amid such a world, if anywhere, our ideals henceforward must find a home. That man is the product of causes that had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave, that all the labours of the ages, all the devotion, all the inspirations, all the noon-day brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of man's achievement must inevitably be buried beneath the debris of a universe in ruins - all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy that rejects them can hope to stand. Only within the scaffolding of these truths, only on the firm foundation of unyielding despair, can the soul's habitation henceforth be safely built. ... Brief and powerless is man's life, on him and all his race the slow, sure doom falls pitiless and dark.

This can lead to the expedient conclusion that we may as well eat, drink and be merry and take what advantages we can out of this material life, even to the point of exploitation of others too witless or too powerless to resist, before our time passes and we ebb away, leading to obdurate claims that religion provides the only antidote to a corrupt degenerate scientific vision, but this is not necessarily the case. One can develop an ethical view that science and the discovery of nature can provide us with an moral sensibility, because we can better know those things which we need to value most highly, such as the preservation of biological and genetic diversity, which has taken a good part of the universe's own lifetime to evolve, so that these resources will not become lost and life can continue to flourish for the future generations. Ironically, this is something that religious believers are generally no better at than expedient individuals, because belief in a creator God leads to notions of the inferiority of nature and the acceptance of ultimate destruction of the 'late planet Earth' in God's 'day of resurrection'.

In the post-Newtonian age of reductionism and artificial intelligence, some materialistic thinkers reach the conclusion that consciousness and free-will are illusions and that we are no more and no less than our functioning brain – in effect biochemical automata. Sam Harris for example, while defending a moral view of the value of nature, tries to claim free-will is an illusion:

You feel like you are a thinker of thoughts - the author of intentions - you feel like you are a subject and commensurate with that feeling is the sense that you are in a position to do what it is you do, to decide to lift my left or right hand and deliberate between the two and I can have reasons for one or the other and I'm in the driver's seat - I really am - and that's where everyone is starting. The problem with that is that objectively we know that everything you are consciously aware of - all your thoughts and your intentions and your impulses and your intentions to resist those impulses - whatever's coming up for you - but we know that's all preceded by events in your nervous system of which you're not aware and which you didn't create and the state of your brain in this moment in every sense is the product of variables that you are not responsible for - you didn't pick your parents, you didn't pick your genes, you didn't pick the environment in which your genome was going to be expressed, you didn't pick the way your interaction with other people and the world sculpted the microstructure of your brain so as to give you the brain you have - you didn't pick the number of receptors you have of every type at each synapse, you didn't pick all the charges that are currently in place in your brain at this moment - you haven't created your neuronal physiology and yet your neuronal physiology is going to give rise to every next thought and intention that shows up for you.

Francis Crick co-discoverer of DNA puts it even more pungently:

"You," your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules. Who you are is nothing but a pack of neurons - although we appear to have free will, in fact, our choices have already been predetermined for us and we cannot change that.

The trouble with these viewpoints is that the veneer of precise causality surrounding the circumstances leading to our assumed deterministic brain process only acts this way in a classical Newtonian universe, in which each cause induces precise effects. But in the quantum universe in which we actually exist, these classical conclusions no longer have validity.

I want to convince you that both of the notions of a morally imperative religious cosmos and a physically deterministic brain with no free will are tragic fallacies and that the actual situation is both far more exciting, provocative and challenging than either of these degenerate philosophies, but that we need urgently to address

our meaning and purpose to avoid these travesties of cosmological reality fatally compromising the Earth's natural fecundity and robustness and doom the vital prospects of the generations to come.

Of course, on both sides, there are also mitigating visions. The Eastern tradition includes Vedantic and Buddhist, notions in which consciousness is central to the vision quest of discovering the cosmic inner self, a path of self-discovery rather than imposed belief, which teaches that egotistical selfishness is simply a form of ignorance, that causes us endless suffering. These traditions include Tantric and Taoist ideas of the complementarity of consciousness and matter, as Shakti is to Shiva and yin is to yang, but they also suffer from inconsistencies, in which the universe is portrayed as a moral testing ground for sentient beings in a round of reincarnation of sentient beings, possibly in animal form, inconsistent with ecosystemic evolution filling all niches including predators and parasites and with the sanctity of individual species as unique and sometimes vulnerable or threatened organisms of incalculable value in their own right.

As noted, there are also 'enlightened humanists', who expound the essential goodness of natural being and of the diversity of life as the cradle and support of human existence in a world in which caring and empathy provide the connection that makes life a meaningful process, which can be made tolerable for all, if we can collectively mitigate, through compassion and informed insight, the ongoing tragedy of the commons perpetrated by people too ignorant, or selfish, to realize the essential coexistence that unites us all.

However ultimately we come back to the crux of the problem. Is life just a meaningless rash of complexity – a planetary surface growth in a physical universe, which cares not a dot for biological or conscious survival, and in which black holes and disintegrating galaxies hold the ultimate fate of all. Or does life have some integral role in the whole cosmological process, as religions insist in all too imperative terms? But in fact a role so different from traditional ideas, that it takes the full sum of our current knowledge, from consciousness research and neuroscience through particle physics to cosmology to even begin to get a hint of an answer which can turn our understanding of the world inside out and with it our senses of time and direction and what ultimate meaning of conscious life might portend.

The Paradox of Consciousness

From birth to death, the sum total of all our experiences - all our dreams , our visions and all our observations of the physical world, and all our notions about it, come exclusively through our subjective conscious experiences. By comparison, our knowledge of the physical world comes only indirectly through our conscious experience, by cross-checking our observations with those of others, to establish such fundamental conclusions as that we are biological organisms that will become unconscious if knocked on the head or die if we cut an artery and bleed out. In turn we become aware of the consciousness of others even more indirectly through their behavior and vivacious personae, which we closely identify with our own conscious existence, while rare instances of deeper conscious connections, such as close relatives or twins noticing when a loved one passes away or has a serious accident, remain anecdotal and ephemeral.

Effectively the world is divided between two complementary realms, the subjective realm of conscious experience and the objective realm of physical existence which we access indirectly through the former, although we recognize physical existence, and with it our biological bodies and brains, to be essential to the existence of our conscious mental states.

Subjective consciousness poses the deepest dilemma for the scientific description of reality. Although neuroscience has produced many new exciting techniques for visualizing brain function, from EEG and MEG to PET and fMRI scans, which show a deep parallel relationship between mental states and specific modalities of brain processes, these go no way in themselves to solving the so-called 'hard problem' of consciousness research – how these purely objective physiological processes give rise to the subjective affects of our conscious experiences. Philosopher Jerry Fodor famously complained:

Nobody has the slightest idea how anything material could be conscious. Nobody even knows what it would be like to have the slightest idea about how anything material could be conscious.

Little wonder then that people, since the dawn of history, have coined origin myths ornamenting their experience of the physical world with fantastic stories of spirits, deities and imaginary realms like heaven and hell, the dreamtime, underworld and afterlife, which, in the minds of believers, remain as real as the physical realm they consciously experience in waking life.

This means inevitably that addressing the question of the meaning of life has to plumb the role subjective conscious experience plays in the cosmological theatre and in the evolution of the physical universe. This brings us immediately to the question of free will.

Free-will, Determinism and Accountability

Complementing subjective consciousness is the notion of intentional will or free-will as it is sometimes, for better or worse, called. With the exception of a few catatonic individuals and extreme skeptics, all of us found our sense of our personal autonomy on our belief in our ability to make conscious decisions over our fate. Actions as simple and seemingly inevitable as getting out of bed and making a cup of coffee to start the day are all accompanied by a sense of conscious choice on which we depend and invest in in all our actions in life, predictable and unpredictable. This situation becomes particularly acute when we have to make life-changing decisions sometimes unsure of the outcomes. To deny free-will is at face value a lunacy equivalent to insisting on a catatonic or automatic reality, over which we have no conscious control.

Traditional religions hand free-will to us as a poisoned chalice. We must be allotted free-will, or we wouldn't have the ability to fall into temptation and become guilty of sin. On the other hand we are given this freedom only to have it denied, by God judging us for every transgression, so we have to obey the bondage of the moral imperative, or be damned. Worse still, we are deemed to be mortally corrupted by original sin – stemming right from the Garden of Eden, where the woman Eve was tempted by the serpent and persuaded the man Adam to eat the fruit of the knowledge of good and evil thinking it to make one wise.

In virtually all societies, the rule of law is founded on the principle that we know right from wrong and are accountable for our actions, in a tacit concession to the idea that we likewise have the free-will to err. Of course, we know from experiments running back to Pavlov's dogs that applying rewards or punishments by pain or fear can act as behavioral inducements or deterrents, without assuming free-will, and indeed deterrent punishments, from incarceration through torture to death, are designed both to punish the guilty party and to warn others of the consequences of doing likewise. Culpability for our criminal intentions and their consequential actions is conceded only if genetic, or circumstantial evidence, can be provided, or by virtue of us not being of sound mind, to mitigate our deeds.

Yet classical notions of the physical universe stemming from Newton and Laplace have led scientific reasoning towards a notion that, not only our actions, but the entire universe is causally deterministic. Laplace in "A Philosophical Essay on Probabilities" famously declared the universe to be a causal determinism:

We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.

The notion of the deterministic classical universe has inevitably led to the idea that free-will is an illusion and that all our actions are determined by our brain function. Consciousness came to be described as a mere epi-phenomenon, a kind of illusory internal model of reality made by the brain to focus awareness on the issues at hand, having no capacity to causally influence our physical actions or behavior, which were all a direct consequence of the firing of neurons in the brain. The growth of computer technology and artificial intelligence has added to this view of human decision-making as simply a computational process.

This approach has ramified into notions that subconscious processing in the brain may precede conscious awareness of an intention to act, leading to controversies over whether conscious will can play any part in one's intention to move even a little finger. In 1983 Benjamin Libet and co-workers asked volunteers wearing electrodes to flex a finger or wrist. When they did, the movements were preceded by a dip in the signals being recorded, which they called the 'readiness potential' - interpreted as the brain preparing for movement, which came a few tenths of a second before the volunteers said they had decided to move. Libet concluded that unconscious neural processes determine our actions before we are ever aware of making a decision. Using contemporary brain scanning technology, researchers have since been able to predict with 60% accuracy whether subjects would press a button with their left or right hand up to 10 seconds before the subject became aware of having made that choice. This doesn't negate conscious willing because these prefrontal and parietal patterns of activation merely indicate a process is in play, which may become consciously invoked at the time of the decision, and clearly many subjects (40% of trials) were in fact making a contrary decision.

The assumption that Libet's RP is a subconscious decision has been undermined by subsequent studies. In one, subjects waited for an audio tone before deciding whether to tap a key. If Libet's interpretation were correct, the RP should be greater after the tone when a person chose to tap the key. The supposed RP was the same whether or not they elected to tap, implying the RP is simply a sign that the brain is paying attention and does not indicate that a decision has been made. Another study explains the RP as simply an indication that brain processes, which could lead to a decision, have crossed a certain threshold. Previous studies had shown that, when we have to make a decision based on sensory input, assemblies of neurons start accumulating evidence in favor of the various possible outcomes leading towards a decision when the evidence favoring one outcome becomes strong enough to cross a threshold. The team repeated Libet's experiment, but this time if, while waiting to act spontaneously, the volunteers heard a click they had to act immediately. The researchers predicted and found that the fastest response to the click would be seen in those in whom the accumulation of neural noise had neared the threshold - something that would show up in their EEG as a readiness potential. concluding that what looks like a pre-conscious decision process may not in fact reflect a decision at all.

Other experiments suggest that in the very moments that we experience a choice, our minds are rewriting history, fooling us into thinking that this choice - that was actually completed after its consequences were subconsciously perceived - was a choice that we had made all along. In 1999, Wegner and Wheatley claimed:

The experience of intentionally willing an action is often nothing more than a post hoc causal inference that our thoughts caused some behavior. The feeling itself, however, plays no causal role in producing that behavior.

Some aspects of our conscious experience of the world do make it possible for the brain to sometimes construct a present that has never actually occurred, for example, in the flash-lag illusion, incorrectly perceiving that a flash which actually happens exactly when a rotating arrow crosses a marker, occurrs after the arrow has crossed. Due to our gatherer-hunter origins, the brain is primed for very rapid visual recognition of moving targets and it does this party by constructive prediction of the future state of a moving object. This can lead to situations where visual illusions can establish that the brain is constructing an image of the future that is incorrect. Some variants of these illusions can also show that sometimes the brain synthesizes a logic of the sequence of events after the fact and interpolates it backwards. This seems paradoxical, but other tests have confirmed that what is perceived to have occurred at a certain time can be influenced by what happens later. This again does not show that the brain is unable to anticipate reality, because it applies specifically to very short time interval spatial reconstructions by the brain, which would normally be more accurate by retrospective interpolation, aiding survival, and thus being selected for.

Regardless of cultural and religious history, belief in free-will appears to be a normal biological condition. In 1998, the International Social Survey Programme asked 40,000 people from 34 countries: "Do we make our own fate?" More than 70 per cent answered in the affirmative. In experiments where volunteers read statements reinforcing or undermining belief in free will, the first group behaved no differently from volunteers who had not been primed to think of free will at all, indicating we naturally act as though we possess it. Moreover those with a greater belief in their own free will were generally rated as performing better than those with weaker beliefs, suggesting belief in free will is effective in our actions. And ironically people don't just believe they have free will, they also believe they have more of it than others.

We will thus reject the notion that free-will is an illusion and that consciousness plays no role in decision-making and present a radically different perspective, based on quantum reality.

Quantum Reality and the Conscious Observer

Two founding discoveries of physics since the nineteenth century have transformed our notion of the classical universe. Special relativity has shown us that space and time and energy and momentum are coupled in such a way as to both define the speed of light as the upper limit for causal propagation, and bringing with it the notion of both retarded and advanced solutions to the fundamental equations of motion – with retarded solutions travelling in the usual direction to later times and advanced solutions being time-reversed.

At the same time, quantum physics has shown us that it is impossible to deterministically specify the state of any fundamental wave-particle, such as an electron, or photon, because energy is equivalent to frequency and momentum equivalent to wavelength, and we can't determine the frequency of a wave at an instant because we need a certain amount of time over several wave beats to make a measurement of a given accuracy, since we have no finer measure than the quantum itself. Effectively the universe has thrown in a cubic centimeter of

chance into the equations – a volume of momentum times distance, or energy times time, within which arbitrarily wild fluctuations can and do occur.

Each quantum manifests discretely as a particle and continuously as a wave. While we can be relatively certain about average behaviors of many wave-particles, for example the photons of light making the interference rainbows we see on a CD or DVD, we can't know where any individual photon will end up. The CD rainbow is an example of a many-slit interference experiment, generated by reflections between the slits forming the data tracks. In the usual experiment, a photon is discretely released as a particle from an excited atom in a light source making a discrete orbital transition to the ground state. It travels as a wave through space, passing through two slits in a barrier as a wave, and traveling on to a photographic plate where it is absorbed discretely by an atom on the plate. Over time, the pattern of these absorptions shows up as bands of dark and light confirming the wave nature of the light emerging from the two slits, and that the photon passed through both the slits at once to make the interference bands. But we have no idea where each individual particle will be absorbed, because all we know from quantum mechanics is that the probability of them being in any particular place varies with the intensity of the wave – the amplitude squared. So a single photon could end up almost anywhere.

Quantum mechanics predicts an overlapping set of probabilities superimposing all the possible states. However when a conscious observer makes a measurement, the superposition of all the possible states in the wave appears to collapse into one unpredictable outcome – the particle is absorbed by a single atom somewhere the amplitude is non-zero in the wave function spreading across space-time. It is as if each photon itself has a form of free will, as long as they conform on average to the wave function intensity. This problem was made famous in Erwin Schrödinger's cat paradox experiment. A cat is subjected to Russian roulette in a closed box driven by a radioactive source with a probability of a half of going off during the experiment, killing the cat. Quantum physics says the cat is both alive and dead with equal probabilities, but when we open the box we find it is either alive or dead and history has been made.

John von Neumann the mathematical physicist who also invented the computer CPU suggested that quantum observation is the action of a conscious mind and that everything in the universe that is subject to the laws of quantum physics creates one vast quantum superposition. But the conscious mind is different, being able to select out one of the quantum possibilities on offer, making it real to that mind. Max Planck, the founder of quantum theory, said in 1931, "I regard consciousness as fundamental. I regard matter as derivative from consciousness." Werner Heisenberg also maintained that wave function collapse - the destruction of quantum superposition - occurs when the result of a measurement is registered in the mind of an observer.

Uncertainty is not just a hypothetical idea about measurement either. The vacuum is teeming with virtual particles of every possible type appearing out of nowhere and disappearing again within the cubic centimeter of chance uncertainty dictates. These virtual particles are also responsible for the forces of nature, such as electromagnetism, which is due to the exchange of virtual photons between charged particles such as electrons. When we apply energy to electromagnetic circuits, for example in a radio antenna, the photons generated making the music on our airwaves are literally virtual photons that have been drawn out of thin air by the oscillating electromagnetic fields picking up virtual photons and making them real by giving them positive energy. Quantum electrodynamics, devised by Richard Feynman, has proved to be the most accurate theory of physics ever, predicting the magnetic moment of the electron due to emitting and re-absorbing virtual photons, agreeing with the experimental result to an accuracy of one part in 10^{10}. Couched in terms of special relativity, all such quantum field theories likewise admit both retarded and advanced solutions.

This picture of quantum uncertainty has been further deepened by the notion of quantum entanglement. This is the spooky 'action at a distance' that Einstein decried: "I don't believe that God is playing dice with the universe". But later this spooky connection became an experimental reality. If we generate two particles in the same wave function, it turns out that sampling one immediately tells us about the complementary one, without limits on their exchanging information at the speed of light. For example an excited atom of calcium needs to radiate two photons together because the excited and ground states are both spin zero, but a photon carries a spin of one, so emitting two complementary ones will cancel the spins out. The atom thus radiates two photons in opposite directions with complementary polarization. Measure the polarization of one along a given axis and you know the other instantaneously in a way that is not bounded by the limits of speed of light communication between the two detectors, since the effect persists even when we change the detector's orientations over time intervals too short for light speed communication to occur between them. Entanglement and related phenomena such as quantum discord show that uncertainty also plays a significant role in the way physical and biological processes occur.

Quantum discord is an extension of entanglement to more general forms of coherence, in which partial correlations induced through interaction with mixed state particles can still be used to induce quantum correlated effects. Quantum discord is a promising candidate for a complete description of all quantum correlations. Coherent interactions can harness discord to complete a task that is otherwise impossible. This advantage can be directly observed, even in the absence of entanglement. Quantum discord does not require isolation from decoherence caused by entangled particles getting knocked out of synch by a third party quantum, and can even derive additional quantum information from interaction with mixed states which would annihilate entangled states. Quantum discord is thus a viable model for processes ongoing at biological temperatures, which could disrupt full entanglement.

Uncertainty and entanglement also raise deep questions about the nature of causality in time. A photon can be absorbed anywhere inside its spreading wave function , but this spreads both in space and time. When light is passing through a semi-transparent medium, it could be absorbed sooner of later, but somehow the universe never makes a mistake resulting in two absorptions, even when a particle is absorbed long after the wave front has passed other locations.

Quantum reality thus has a form of hand-shaking between past and future, which we can see more clearly in the Wheeler delayed choice experiment. Supposing we look out at a very distant galaxy whose light was emitted shortly after the universe began, which is gravitationally lensed by a nearer one so, we can see two split images, as in the double slit experiment because the light has followed two paths around both sides of the intervening galaxy. If we bring these two together in a detector, we will get an interference pattern confirming the photon went around both sides of the intervening galaxy on its way here, but if instead we put separate photon detectors pointing at each image, we will find it went only around one side of the galaxy. In this case the interference fringes disappear just as they do in the double slit apparatus if we try to detect which slit the photon went through, but here we are making the choice long after the photon traversed the universe. It is thus clear that, within the wave function, there is a hand-shaking between past and future, in which future absorbing states act as boundary conditions on the collapse of the wave-function to the particle, as definitively as the past emitting state(s). This is also true of entangled states and means that the physics inside entanglement in a fundamental sense anticipates future absorbing states.

This doesn't mean that entanglement or uncertainty can be used to deterministically predict the future, because entanglement can't be used to send a causal message faster than the speed of light. It is just the correlation between internal sates that is instantaneous and has to be to avoid particles appearing out of nowhere more than uncertainty allows.

A central error made by people criticizing free-will is that the quantum universe is divided between deterministic laws, including both Newtonian mechanics and the Hamiltonian wave functions of quantum mechanics, the only exception being the probability laws of quantum mechanics giving rise to particle ensembles, thermodynamics and kinetic processes. These are, in turn, claimed to be as unyielding to free-will as determinism, because we are merely replacing stipulated actions by law with random unspecified actions. Since the universe is governed by unyielding determinism and unrelenting randomness, the notion of free-will is meaningless, even in the quantum universe. This then enables the argument to descend to a reductionism, in which particulate molecules interact kinetically, reducing the brain to a complex probabilistic automaton.

Carlo Rovelli, a gravitational theorist, makes exactly these mistakes claiming that:

Free will has nothing to do with quantum mechanics. We are deeply unpredictable beings, like most macroscopic systems. There is no incompatibility between free will and microscopic determinism. ... The issue has no bearing on questions of a moral or legal nature. Our idea of being free is correct, but it is just a way to say that we are ignorant on why we make choices. The first is that the indeterminism of quantum mechanics is governed by a rigorous probabilistic dynamics. The equations of quantum mechanics do not determine what will happen, but determine strictly the probability of what will happen. In other words, they certify that the violation of determinism is strictly random. This goes in exactly the opposite direction from human freedom to choose. If an element of randomness is sufficient to account for free will, there is no need to search it into quantum uncertainty, because in a complex open system such as a human being there are already many sources of uncertainty, entirely independent of quantum mechanics. The microscopic atomic dynamic inside of a man is influenced by countless random events: just consider the fact that it occurs at room temperature, where the thermal motion of the molecules is completely random. The same balance between rigidity and chance plays an important role in our brain, which functions, in spite of the illuminating similarities with good software, because of the ubiquity of statistics in his working. ... Our brain is a machine, but it is a machine that works in a manner where statistical elements play a continuous and persistent role, next to deterministic functions.

The problem with this approach is that we can exert the strictness of the probability interpretation only when a process is repeated in a systematically consistent way, as in an interference experiment to form a statistical particle distribution. If we allow only one event to occur in a given context, such as letting one photon through the apparatus, we simply don't know where it will end up. But all human decision-making is of this second type - that is it is not repeated - history is made and a new situation results. Evolution through mutation shares this precisely at the quantum level, which never fully converges to the probability interpretation since many mutations are adventitious and then become fixed by selection. The brain shows rich avenues for quantum fluctuations of this kind to become amplified into global activation of new states and then fixed by synaptic changes involved in long-term potentiation have been found to lead to epigenetic changes.

Peter Tse has an interesting answer:

If the brain sets up criteria for future firing, and if spike timing is made random by the amplification of quantum-level events in the synapse, it is down to chance how these criteria are met. The inputs that meet criteria cannot be predicted - the outcome depends on which spikes coincidentally arrive first. ... The missing piece is that neurons can rewire each other. Spikes don't just trigger subsequent spikes in other neurons. Within milliseconds, they can temporarily change the degree to which synapses -- the nerve structures that pass signals to other neurons -- trigger future spikes ... rapid bursts of spikes trigger the opening of specialised synaptic receptors, altering the responsiveness of neurons to subsequent spikes. ... With synaptic reweighting, mental events don't change their present physical basis. They change the neuronal basis of possible future events. But this alone is not enough for free will. The brain of a zombie who lacked consciousness could use this mechanism too, but we would not say it had free will. To have free will requires that our self - that which we feel directs our attention around our conscious experience - has some say in the matter of what we do or think. If consciousness plays no part in the synaptic reweighting process, there is hardly a free will worth having. Fortunately, the neural activity associated with consciousness does play a necessary role.

He illustrates this with the brain deliberating an outcome in a novel situation, which has features that have not occurred previously, leading to a new response as a result of the unstable brain dynamics, which then becomes a process in the real world realizing the outcome. We could in principle then make verifiable tests that consciously willed actions do indeed result in historically verifiable outcomes, closing the circle.

When we involve quantum entanglement and its generalized forms such as discord, the stakes become more interesting because we have no model of how the universe actually correlates such processes. Hidden variable theories have been proposed. David Bohm's pilot wave theory, for example, models quantum processes in terms of particles having a real location modified by a quantum potential which acts at a distance in such a way as to generate the same outcomes as those predicted by quantum mechanics.

Strong measurements that disturb the quantum state cannot be used to investigate an ongoing wave function because they will cause wave function collapse. For example, testing whether a particle has passed through one slit of a two slit apparatus destroys the coherent interference fringes, but weak quantum measurement which only marginally perturbs the wave function, e.g. by a small change in polarization, can be used to build up a statistical profile of how a particle traverses its wave function.

Weak quantum measurement can be performed in a double slit apparatus generating single photons using a laser stimulated quantum dot and split fiber optics and it shows us what the trajectories look like inside the wave function. The overlapping wave function is elliptically polarized in the *xy*-plane transverse to the *z*-direction of travel. A calcite crystal is used to make a small shift in the phase of one component, while the other retains the information, subsequently leading to absorption of the photon on a charged coupled device. By combining the information from the two transverse components at varying lens settings, it becomes possible to make a statistical portrait of the evolving particle trajectories within the wave function. Pivotally, the weak quantum measurement is made in a way, which is confirmed only in the future of the ensemble when the post-selection absorption takes place.

When we examine the result, the internal trajectories look consistent with the Bohmian interpretation. Thus, rather than a universe with temporal determinism, with causes strictly preceding effects, interrupted by purely random uncertainty variables, we may be actually living in a universe with a hidden variable interaction with hand-shaking boundary conditions imposed symmetrically by both past and future states.

Weak measurement also suggests that, in some sense, the future is determining the present, but in a way we can discover conclusively only by many repeats. Focus on any single instance and you are left with an effect with no apparent cause, which one has to put it down to a random experimental error. This has led some physicists to suggest that free-will exists only in the freedom to choose not to make the post-selection(s) revealing the future's pull on the present. Yakir Aharonov, the co-discoverer of weak quantum measurement sees this

occurring through an advanced wave travelling backwards in time from the future absorbing states to the time of weak measurement. What God gains by 'playing dice with the universe', in Einstein's words, in the quantum fuzziness of uncertainty, is just what is needed, so that the future can exert an effect on the present, without ever being caught in the act of doing it in any particular instance, neatly explaining why no subjective account of prescience can do so either. Post-selection can also induce forms of entanglement in particles even if they have no previous quantum connection coupling their wave functions.

The link with Bohm's pilot wave theory became reinforced when a critical experiment demonstrated the existence of so-called "surreal Bohmian trajectories" which could violate the predictions of quantum theory. The experiment first prepares a pair of highly entangled photons with complementary polarization and then passes one into a double slit apparatus in which the photon to be measured is directed to one or other slit depending on its entangled twin's polarization. The measured photons are then passed through an apparatus to do weak quantum measurement of their trajectories as an ensemble and then detect the eventual position destructively. However when weak measurement is used to detect the trajectory close to the slit. it confirms that the photon has gone through the correct slit according to its assumed polarization as subsequently measured by sampling its entangled twin. However, as the position of weak measurement moves towards the photographic plate the predictions fall to an even superposition of the two polarizations. Since the weak quantum measurement is a physical realization of the ensemble trajectories going to this particular point on the plate, the surreal trajectories are real but the prediction made of the spin by the entangled twin has become changed. This implies in turn that changes have occurred between entering the slits and hitting the plate of a non-local nature, implying the there is substance to the Bohmian reality.

Quantum uncertainty in brain processes could thus provide a loophole both for free will and for conscious anticipation, if decision-making corresponds to unstable processes where quantum uncertainty means we can't predict the outcome of the brain state. This brings us to the question of the role chaos may play in generating unpredictability.

A Perfect Storm at the Edge of Chaos

A third discovery in physics much closer to home paradoxically took much longer to become recognized. The classical paradigm of the rule of order meant that physicists thought all real phenomena would have to be structurally stable and not disintegrate under arbitrarily small perturbation, until Lorenz studying turbulent weather in the 1960s came up with a system of equations which demonstrated the 'butterfly catastrophe' – that for some 'chaotic' systems, arbitrarily small perturbations can grow exponentially, so that the disturbance of a butterfly's wings in Hawaii can later grow into a tropical cyclone hitting Mexico. Chaos also has two other key properties – it thoroughly mixes dynamical space topologically and it is permeated with a dense set of repelling orbits, while ordered systems converge toward a stable set of attracting orbits.

Earlier Werner Heisenberg had prophetically commented: "When I meet God, I'm going to ask him two questions, 'Why relativity?' and 'Why turbulence?' I really believe he will have an answer to the first" - implying the second, i.e. chaos is the very nemesis.

Suddenly people realized that chaotic instability underlay a whole raft of phenomena, from fluctuations in the populations of rabbits through to the forms of snowflake-like fractal sets in dynamical systems. Evolution and climax ecologies both operate at the so-called 'edge of chaos'. Complex biological systems are particularly prone to dynamics which include transitions in or out of chaotic phases, and these include the very phenomena in the brain we associate with conscious decision-making, where all the competing factors relating to an uncertain decision we are about to make, lead to an unstable tipping point.

Chaos is essential to such processes, because it provides a form of 'annealing'. Ordered dynamical systems tend to be totalitarian, getting stuck by drawing every state into one of their stable attractors, making it very difficult to avoid a 'fait accompli'. Chaos enhances a system's dynamical unpredictability, so it can end up almost anywhere, avoiding it getting stuck and enabling it to form or enter a new attractor as we make a transition from chaos to order.

Quantum systems engaged in chaotic dynamical processes can also enter paradoxical states of entanglement. Many closed quantum systems display repression of classical chaos. For example a confined wave function under chaotic energisation, such as the quantum stadium, displays scarring of the wave function, causing the probability to cluster around the repelling periodic orbits. However this is not true for open or interactive systems. An indication of how the transition from classical to quantum chaos might lead to complex forms of

quantum entanglement can be gleaned from an ingenious experiment forming a quantum analogue of the kicked top using an ultra-cold cesium atom kicked by both a laser pulse and a magnetic field. In the experiment the lack of a dip in linear entropies in the chaotic regime indicates entanglement with nuclear spin, showing quantum chaos can lead to new forms of quantum entanglement.

Studies of brain waves in the electroencephalogram show that these are broad-spectrum excitations associated with chaotic processes, rather than the narrow peaks we associate with ordered resonances. Work by Walter Freeman in the 1990s showed that processes such as sensory recognition and learning can be explained by dynamical evolution of chaotic strange attractors through transitions in and out of chaos, in which a high-energy chaotic phase frees up the dynamic to explore the phase space of possibilities, while a lower-energy transition back towards order seals a perception or decision into place. Attractor based dynamics can also explain how learning occurs if a new situation arises by forming a new attractor by bifurcation out of chaos.

Moreover the brain consists of a fractal-like system of interconnected neuronal assemblies, where in cases where there are potential tipping points, instability in a single neuron can lead to cascades of instability in larger neural assemblies, leading ultimately to a change in the whole brain state, as has again been demonstrated by experiment. Between the global, cellular and molecular levels are a fractal cascade of central nervous processes, which, in combination, make it possible for a quantum fluctuation to become amplified into a change of global brain state. The neuron is itself a fractal with multiply branching dendrites and axonal terminals, which are essential to provide the many-to-many synaptic connections between neurons, which make adaptation and the representation of reality possible. In all tissues, biological organization is achieved through non-linear interactions which begin at the molecular level and have secondary perturbations upward in a series of fractal scale transformations through complex molecules such as enzymes, supra-molecular complexes such as ion channels and the membrane, organelles such as synaptic junctions, to neurons and then to neuronal complexes such as cortical mini-columns and finally to global brain processes.

Because neurons tend to tune to their threshold with a sigmoidal activation function, which has maximum limiting slope at threshold, they are capable of becoming critically poised at their activation threshold. It is thus possible in principle for a single ion channel, potentially triggered by only one or two neurotransmitter molecules, if suitably situated on the receptor neuron, e.g. at the cell body, where an action potential begins, to act as the trigger for activation.

The lessons of the butterfly effect and evidence for transitions from chaos in perceptual recognition suggest that if a brain state is critically poised, the system may become sensitive to instability at the neuronal, synaptic, ion-channel, or quantum level. A variety of lines of evidence have demonstrated that fluctuations of activity in single cells can lead to a change of brain state when the global brain state is critically poised for example under stochastic resonance, in which the presence of chaotic excitation or noise, somewhat paradoxically, leads to the capacity of ion channels to sensitively excite hippocampal cells and in turn to cause a change in global brain state. Specific neuronal circuitry also facilitates such processes. Chandelier cell activation can result in poly-synaptic activation of pyramidal neurons that drive active output to other cortical regions and to the peripheral nervous system, in such a way that single action potentials are sufficient to recruit neuronal assemblies that are proposed to participate in cognitive processes.

Confirmation of edge of chaos processing has come with several recent experimental studies. Consciously perceived stimuli appear as islands of relative stability in a chaotic sea of unconscious processing. High density EEG experiments confirm that the brain, is self-regulated at the boundary between stable and unstable regimes, a form of self-organized criticality, allowing it to maintain high susceptibility and sensitivity to stimuli. During loss of consciousness due to anesthetics, the number of resonance modes at the edge of instability decreases, independently of the type of anesthetic and specific features of brain activity, but drifts back toward the boundary during recovery of consciousness. These findings imply that dynamics at the edge of instability are essential for maintaining consciousness.

Enter the Holographic Brain

However, there is another aspect of brain activity that is also critical for our understanding, which comes very close to the idea of quantum measurement. A central way the brain distinguishes signal from noise is whether excitations are “in synch’ with one another – i.e. they rise and fall in time with one another coherently. Circuits which do this tend to be reinforced and couple together to make a larger scale dynamical system. This attribute is termed ‘phase coherence’ because the phases of the two waves – i.e. the angle between rise and fall, flow together.

Karl Pribram coined the term 'holographic brain' for this dependence on phase-front processing, because it is similar to the way a holographic photograph stores 3-D wave information on a photographic plate using coherent laser light, where all the photons are caught 'in synch' in the same wave function.

One can thus picture brain processes as arising locally and those which achieve phase coherence coupling together and competing with others out of synch, with global attention processes scanning for dominant coherences that subsequently rise to conscious attention. This process is a very close analogy to quantum measurement where wave beats are a direct discrete measure of phase coherence.

Of course there are many people who will then object that the firing of even individual neurons happens on a far grosser scale than individual quanta at the molecular level and the uncertainty can play no significant role in conscious decision-making. This is again incorrect, because neurons can self-tune to their activation threshold with sigmoidal acute activation triggers so that changes at an individual neurotransmitter receptor or even a single ion channel at a critically poised neuron can result in activation, leading in turn to an escalating cascade of activated neural assemblies.

Moreover many sensory processes are known to be sensitive down to the one quantum level. Recently experiments have verified, for example, that it is possible for the human eye in the limit of sensitivity, to detect a single photon. Membranes of cochlear cells oscillate by only about one H atom radius at the threshold of hearing, well below the scale of individual thermodynamic fluctuations and vastly below the bilayer membrane thickness. Moth pheromones are similarly effective at concentrations consistent with one molecule being active, as are the olfactory sensitivities of some mammals.

Furthermore, although long distance transmission of signals is driven by the discrete pulse-modulated action potentials of pyramidal neurons, many neurons at the organizing centre of neural assemblies have graded potentials with continuous variation, so the organizing process cannot be reduced to a digital process like that of a silicon-based digital computer.

The nature of wave-front processing raises a question about whether brain excitations might be more than an analogy with quantum processes and actually be in some sense inflated quantum excitations. In such a situation, coherence between excitations would be equivalent to quantum entanglement and raise intriguing questions about the causality of brain processes. We would move beyond merely citing quantum uncertainty as a loophole in determinism and enter unknown territory about the space-time properties of entangled brain processes.

Biology has been discovered to contain a challenging diversity of quantum phenomena. Enzymes commonly use quantum tunneling as a means to traverse the activation barrier. When a photosynthetic active centre absorbs a photon in a plant, the wave function of the excitation is able to perform a quantum computation by superposition, which enables the excitation to travel down the most efficient route through the molecular web to reach the chemical reaction site. Quantum entanglement is believed to be behind the way some birds navigate in the magnetic field. Light excites two electrons on a molecule and shunts one of them onto a second molecule. Their spins are linked through quantum entanglement. Before they relax into a decoherent state, the Earth's magnetic field can alter the relative alignment of the electrons' spins, which in turn alters the chemical properties of the molecules involved. Quantum coherence imaging is an established technique in tissue imaging, demonstrating quantum entanglement in biological tissues at the molecular level. Interesting candidates for entanglement in the brain could occur as a result of spin are Calcium phosphate Posner's clusters, which have an estimated the coherence time of over a minute.

If the brain is able to generate entangled excitations the lifetime of these excitations could create a potentially anticipatory loophole on a similar time scale to the conscious moment of hundreds of milliseconds which might provide exactly the anticipatory advantage that resulted in the evolution of consciousness nervous systems to avoid potentially lethal predator attacks.

To put this in a molecular context and to see the whole picture, we now need to throw the covers off the cosmological universe and where life fits into the picture.

Origin Myths and Apocalyptic Allegories

Let's turn back for a minute to traditional ideas of how the universe began. Cultures since the dawn of history have devised creation myths to explain how we find ourselves in the world. The San Bushmen, one of our most

ancient founding cultures that go back 150,000 years to the mitochondrial Eve, tell a story of a creator deity making in turn a second god of misfortune and chaos and female partners for them both, who in his earthly existence was a supernatural trickster capable of assuming any form, who changed people into animals and brought the dead back to life. He created the earth with holes in it where water could collect and water and rain, the sky, the sun, moon, stars and wind, and all the plants and animals and gave them names. Then he put life into humans and gave to them all their weapons and implements and the knowledge of how to exist in the wild. And he ordained that when they died they should become spirits, who would live in the sky with him and serve him. The Bushmen do not worship their deities in fear or supplication, in the way the major social religions do, but rather see them as quizzical elements far off in their own domain, who manifest indirectly through natural phenomena and the vagaries of fate.

Although charmingly evocative, the sabbatical creation sequence of Genesis one defies the natural order in a way that makes no cosmological or biological sense. The universe is a logos - enunciated verbally - 'Let there be light and there was light'. Light, immediately adopting the forms of day and night, is created before the Sun, Moon and stars. The photosynthetic plants are also impossibly created before the Sun. The firmament of the heavens is "raqiya" a beaten hemispherical bowl, dividing waters above and below, in which the stars are fixed as adornments and the Sun and Moon are mere lamps to light the day and night. Earth is a flat domain created by bunching the waters under heaven to one place. The fishes and whales and the birds are created a day before the land animals and long after the plants. The Sabbatical deity is 'Elohim – God in the plural - with implications of being a deity partnership in consort, culminating in humans being made female and male in their likeness. This is echoed in the proverbs where Wisdom portrayed as a female who says "I was with him from everlasting before the Earth was." To try to use this charming allegory to deny the evolution of natural life in the name of religious belief is a frank disgrace of bibliolatry the written word version of idolatry.

The Eden tale stands in stark contrast. A lone and lonely God sets up a tender trap in paradise with the Tree of Life and the Tree of Knowledge of Good and Evil. The woman Eve, conceived out of Adam's rib, is tricked into eating the fruit of knowledge, leading to woman being cursed as the 'devil's gateway' to suffer the pains of childbirth and be ruled over by her husband, giving patriarchy free reign, and both woman and man doomed to mortality to live struggling with the thorns and thistles, exiled from the Garden by a flaming sword.

With the development of urban culture, deities became totems for city-states and empires vying for dominance. The nature of God underwent a change, to become a moral deity cursing the people for infidelity or selfishness to enhance the internal cohesion of the state. The rise of patriarchal dominance at the same time resulted in God becoming connected with the control of female reproduction. Recent genetic evidence comparing Y-chromosome and mitochondrial evolution has shown that, with the advent of the agricultural era, the reproductive sex ratio went from about a fairly natural ratio of 2 women to each reproducing man since all women can get pregnant but only some men have partners, to 17 to 1, due to powerful landlords in agrarian societies controlling female reproductive choice for themselves in harems and sexual slavery.

Yahweh became the abstract totem deity of the bride Israel, in the same way that other deities, from old El of Canaan, to Marduk of Babylon were totem deities. As successive societies rose and fell, so the cosmology evolved by cross-fertilization. Originally in Hebrew religion there was no place for heaven, or hell, just Sheol, a primitive underworld of the dead. It was only with the influence of Zoroaster that the idea of apocalyptic renovation in a future day of judgment arose and became incorporated into the thought of exilic Jews in Babylon, who were then allowed to return to Israel by Cyrus the Mede, 'anointed by God' as a Jewish messiah.

In modern Judeo-Christian thought, we end up with a syncretic false perspective, in which the universe has become a cosmic moral passion play in which we are condemned to torture or given eternal life in a sexless heaven with angelic wings which makes no physical sense in the rarified upper atmosphere or outer space and which has no meaningful future creative or enlightening purpose, frozen forever in eternal time.

As we have learned from sociobiology, morality is not an imposed fundamental of the cosmological design, but a natural evolutionary feature of animal and human societies, in which intra-social strife is repressed to enhance inter-social domination. In the Judeo-Christian cosmology we are left with a vestigial creation myth in Genesis 1, inflated by the believing mind into claims that the Earth is only 4000 years old, and that, without any shred of corroborating evidence, or even a plausible description in the scripture of how this might have come about, that the wooly-haired God has created the universe and all life within it by breathing on it, or naming it in the same way the San Bushmen imagined it was done.

The Quranic account, while couched in Arabic poetry, is even more insubstantial, revolving around a simplified Eden story, leading to fantastic tales of a sexual heaven where female houris are made anew as virgins every day for the pleasure of men, and the day of judgment is accompanied by eclipses and the Moon being torn in two, the one commonplace and the other a cataclysm impossible except in the birth of the solar system.

When we turn to the teachings of the Upanishads and Buddhism, we find a more subtle cosmology that has become centered around the conscious quest for enlightenment. The entire perspective is that of the sentient conscious mind seeking the cosmic self within. We have Vishnu the sustainer dreaming the universe in the form of Brahman manifesting the phenomena of existence, as a lotus out of Vishnu's navel. In other accounts we have Shiva as the conscious avatar in sexual embrace with Shakti-Kali as material and temporal reality and in their retreat from cosmic union, thus manifesting all the phenomena of temporal existence, astutely portraying the existential condition as an intimate sexual union of subjective mind and material body whose truth has become lost in the myriad reflections of sentient beings engaging the material world. The intrinsic value in these accounts lies in their being recognized as allegories, just as the sabbatical creation is a beautiful allegory, but a fraudulent danger to our survival when fraudulently claimed to be an actual cosmology.

The Buddhist account is a story of releasing sentient beings from the grasping bondage and torments of the ego, in a philosophy of undivided phenomena, all of which are undivided because they are integrated states of mind, leaving the objective physical world as part of Maya, the domain of illusion. The end result is a cosmology of conscious cycles of incarnation in which only the sentient being exists and has validity and all the diversity of nature, from simple organisms to humanity, are caught in a moral cosmology which is in fundamental conflict with nature, because it fails to recognize the difference between an endangered bird, and a feral rodent which eats it, as both are simply sentient beings. It is another moral cosmos, in which the wheel of life, containing realms, from hell, through hungry ghosts to titans, are archetypal reflections of differing states of mind. It is thus again not a valid cosmology, but a psychological theory of mind, claiming to address the existential dilemma, without offering a realizable description of nature or the physical world.

None of these accounts contain a remotely plausible or verifiable cosmology of the universe, nor do they make any meaningful explanation of the origin or purpose of conscious life in the cosmological process. The struggle to understand the natural universe as it is, was not achieved easily. People like Galileo, who challenged the Earth-centric view, were threatened with excommunication, and attempts have been mounted ever since to insist, regardless of the lack of evidence, that God created the universe either by command or by artifice in the manner we create artifacts and machines, and to deny the natural emergence and evolution of life.

Coming to Terms with the Cosmological Universe

The universe has proved to be vastly older, huger, more populous, varied and far more deeply confounding than any of the ideas of traditional belief systems. Natural reality is inscrutable and existentially challenging and although we have a fairly clear idea of the general picture, the exact description of life, the universe and everything isn't completely signed and sealed. However this is a much more healthy situation than a religious cosmology that resists the evidence and seeks a dominant regime of order through preconceived beliefs. It's a sign of our growing maturity to accept uncertainty in the cosmic description.

In our own galaxy alone there are a hundred billion stars, a good proportion of which are now known to have planetary systems. But there are also a hundred billion galaxies, stretching out to the limits of the observable horizon where we are effectively seeing back to the cosmic origin, because their light has taken over ten billion years to reach us. We also know the universe had an 'explosive' origin around this time, around 13 billion years ago, because there is a universal cosmic background radiation at around four degrees absolute, which corresponds to the hot blast, later cooled almost to zero by the expansion of the universe, just at the point that the hot opaque charged plasma condensed into neutral atoms, allowing the universe to become transparent and the photons to escape.

But the 'big bang' was no ordinary explosion. It seems to have occurred from a state of high symmetry immediately followed by a phase of exponential expansion in around 10^{-12} seconds, which goes by the name of cosmic inflation. Like many other aspects of the universe, life and consciousness, inflation is still in the process of confirmation, but it ties together with some other issues about how the forces of nature linking matter and radiation that govern everything from how stars and galaxies form to molecular life and evolution came about. Nor is the 'big bang' a candidate for God's creation of the universe, because according to relativity, space and time would come together as the lines of longitude do at the south pole, so we don't necessarily have any meaning of time 'outside' or time 'before' the origin, although in some models, inflation is like a fractal, leaving

behind universes like ours, and in others the big bang may have resulted from a bounce out of a big crunch. The ideas here are as wild and varied as the uncertainties.

Nevertheless there are four well-known forces governing the evolution of the universe, electromagnetism making light, electromagnetic phenomena and driving molecular chemistry; the weak force governing the radioactivity that exchanges neutrons and protons; the strong (colour) force governing the high energy attractions that hold the nucleus together, causing nuclear fission and the fusion driving stars, and gravity. These are now very different, but they appear to converge at very high energies and the idea is that, just after the big bang, they were a single super-force and that inflation occurred because the universe had a universal anti-gravity caused by the fact that, although very hot, the universe was a little below the unification temperature, causing a negative mass-energy. Almost as soon as it began and made the universe huge, the symmetrical state froze out like a ferromagnet, where the polarized magnetic state is lower energy than the symmetrical state, giving us the twisted form of the forces we see today where the weak force is chiral, the strong force goes in three colours of quark and there is an excess of matter over anti-matter, with atoms and molecules having exclusively positively charge nuclei and negative charged orbital electrons. Inflation also explains why the total kinetic energy of the universe flying apart is almost exactly equal to its gravitational potential energy, leaving us unsure whether it will expand forever or collapse back again.

Each of the quantum forces is mediated by radiation particles called bosons, for example the photons that are exchanged between charged particles such as the electron, which along with the positively charged proton and neutron constitute molecular matter. These matter-forming particles are called fermions and can only group in pairs, causing matter to become incompressible, while bosons can clone any number together, as in a laser.

But this isn't the whole story, because there are two dark clouds hanging over cosmology. The first is dark matter. When we look at a galaxy, there simply isn't enough mass in the stars and black holes formed by large stars which have gobbled up other matter, exploded and collapsed under their massive gravity to hold a spinning galaxy together. Nearly all the mass must be hidden in some other massive form of 'dark matter'. At the same time, careful measurements show the universe is not just expanding, but the expansion is accelerating, so there is another entity 'dark energy' causing the acceleration. No one yet has a clear answer to what either of these actually are, although there are many competing theories.

Also we don't have a unified 'theory of everything' that can fully unite gravity with the other three forces of nature. There are several candidates extending the standard model which unifies the other three, but none of the ideas such as super-symmetry between bosons and fermions, or its extension to superstrings, where particles become loop vibrations, has achieved confirmation so far in experiments such as the LHC.

Molecular Complexity and the Origins of Life

Nevertheless, the four forces of nature induce an interactive hierarchy in the quantum forms that matter and radiation can assume. After the cosmic background separated, the universe consisted mostly of atoms of hydrogen with a little helium, until the first galaxies formed by gravitational collapse and the first stars began to shine. From then on, the stars became furnaces burning hydrogen under the strong nuclear force ultimately generating the heavy elements by nuclear fusion, until they explode in a supernova. These elements are then swept up into the gas clouds forming smaller long-lived stars like the sun, which then have planets containing a spectrum of the lighter and heavier elements we find on Earth.

The forces of nature are also prone to chaotic interaction due to their non-linear force fields, that generate extreme variety in planetary and molecular environments. Anyone who looks at images of the solar system planets and their major satellites can see how varied and different they have become. The same is the case for molecular systems. The molecules of life centre on H, C, N and O with an emphasis on the most strongly covalent elements in the first row as backbone building components that are also cosmologically abundant as light elements. These also form the strongest multiple bonds such as $-C \equiv C-, -C \equiv N, > C = O$, which can be found in molecular gas and dust clouds such as in the Orion nebula where new stars and solar systems are being formed.

However these strong multiple bonds are unstable, because their π orbitals are at higher energy than a single σ bond, so they polymerize to form a variety of heterocyclic CNO molecules, which turn out to be precursors of life, such as nucleic acid bases, amino acids and many other prebiotic molecules. Complex molecular precursors to life have thus been found both in interstellar gas clouds, and in carbonaceous meteorites that are associated with the primordial material on the outer edges of the solar system, which would have rained down on the early Earth

in abundance, providing much of the carbon and nitrogen in the Earth's crust and supplying the Earth with a rich brew of organics.

This puts complex molecules at the top of the cosmogenesis hierarchy, because they are the cumulative interactive result of all the forces of nature acting in order of their energy interactions. You cannot find greater complexity in black holes, or the centre of stars, because the energies are too catastrophic to allow all the forces of nature to generate full complexity. Molecular complexity on the planetary surface thus becomes the Sigma of paradise on the cosmic equator - life in the universe is as significant in cosmological terms as the alpha of the cosmic origin or the omega of its final end. The interaction of the bio-elements is a thus cosmological process based on each of the chemical elements generated by nucleo-synthesis contributing unique properties, due to the non-linear nature of charge interactions, which in combination with one another under the quantum orbital periodicities, provide the boundary conditions for a structurally unstable complex quantum system to emerge.

Strong covalent bonds of the principal bio-elements H C, N and O, which as we noted have the strongest covalent bonds among the elements, provide the central backbones of complex organic molecules. This interacts with a graduated increase of electronegativity in C, N and O producing a distribution from non-polar C-H to the highly polar O-H found in the diverse quantum properties of H_2O, bifurcating the reaction medium into non-polar (oily) and polar (aqueous) phases, becoming the source of micelle, stacked double helix and membranous structures ubiquitous in living systems. The heterocyclic double and single bonded rings of the first generation molecules such as the nucleic acid bases provide unique electronic properties including photon absorption from delocalized electronic orbitals. Second row elements induce complexifying perturbations. Unique properties of P as dehydrating condensing agent in the form of $-PO_4^{3-}$ driving key molecular polymerizations and energy processes and the milder covalent S-S to S-H bonding of S provide key additional quantum properties. These are again complemented by the strongly ionic properties of Na^+, K^+, Ca^{++} and Mg^{++} along with Cl^-, in interaction with the diverse polar, H-bonding, and ionic properties of H_2O. Finally the transition elements add unique catalytic properties, due to their higher orbital transitions. One can thus confirm that the interaction of the bio-elements is a culmination of the cosmological process that generated the forces of nature in their polarized chiral condition as a central interaction of the chemical elements expressing their graduated periodic and non-linear quantum properties in a cosmologically optimal form.

Furthermore, the fractal process of complexity doesn't stop at individual bonds. Weaker H-bonds, polar and non-polar interactions, and van der Waal forces act cooperatively to make molecules into fractal structures where catalytic energetics are a function of cooperative weak bonding, leading to molecules such as proteins and nucleic acids with complex tertiary structures based on polymer chains, helices and modifying side groups resulting in active sites with high catalytic power. In a fundamental sense, once life begins, the ultimate culmination interactively of the cosmological forces of nature is excitable tissue, an integrated dynamical quantum fractal, where complex molecules aggregate into molecular complexes, and these into cellular organelles, cells, tissues, organs and organisms, with the ultimate interactive culmination being the conscious brain.

Then there is the naked lunch of negentropic free-energy, bathing the whole process. Solar systems, by their genesis, set up a situation of negative entropy, where there is a free input of energy in stellar radiation bathing the planetary surface. This leads to all manner of secondary effects in terms of storms, lightning, and ionizing radiation, all of which can induce molecular polymerization. In addition, the chemical and geological forces are far from equilibrium, with the early Earth having massive tectonic and volcanic activity. Ultimately this becomes the source of all photosynthetic energy driving life on Earth.

But the situation is even more auspicious for the emergence of life. There are unique chemical reactions that can induce a chemical Garden of Eden scenario out of the cosmological milieu. One of these is the reaction of alkalinizing olivine with acidic sea water in a higher carbon dioxide atmosphere than we have today. Olivine is a cosmologically abundant iron-aluminum silicate mineral, which is ubiquitous in the galaxy and abundant on rocky planets and meteorites. Olivine vents are still fizzing at the Lost City in the mid Atlantic and off the coasts of Spain and Iceland, but they would have been vastly more abundant on the early Earth. The Lost City field itself has undergone continuous activity for some 30,000 years - a hundred times longer than hydrothermal vents. It undergoes a chemical reaction with sea water, generating hydrogen and methane to form columns of carbonate full of fizzy columns, which can both concentrate organics exponentially and generate key non-equilibrium reactions supporting central oxidation-reduction pathways driving living processes.

Biogenesis is a second bridging point, where the religious try to assert that God must have intervened to set the process in motion, but this is a misconception. The key polymers, including, both the nucleic acid RNA, which can

both replicate itself and also act as an enzyme-like catalyst, and the polypeptides leading to proteins, are direct products of the molecular energisations found in interstellar gas clouds, also found in carbonaceous meteorites and as products in prebiotic experiments. Adenine, one of the four nucleic acid bases, is simply $(HCN)_5$. Several new counter-intuitive routes have been discovered which help bridge the gap all the way from simple precursors to the nucleotide units making up RNA, utilizing phosphate as a dehydrating binding agent in the first polymerizations, as it is in cellular energetics today. Moreover living polymers need to be thermodynamically unstable, or polymerization would run itself to death and life would have ended before it began in a dob of gunk, so a long period of a rich non-equilibrium environment is exactly the conditions which can bridge the gap to replicating living systems.

The geological evidence suggests that living systems emerged around 3.8 billion years ago, almost as soon as the temperatures fell enough for liquid oceans to form, only a few hundred million years after the formation of the solar system around 4.1 billion years back, although this time manifestly dwarfs the few days at most of origin of life experiments on Earth today.

Evolution, Diversification and the Metabolic Genome

Life depends critically on molecular replication provided by the double helix of nucleic acids and the complementary base pairs adenine-uracil and guanine- cytosine, which form a hydrogen-bonded zipper of stacked heterocyclic CN molecules - purines and pyrimidines. All molecular process are also doomed to 'random' entropy-increasing effects, as are all thermodynamic processes. Thus replicating life, no matter how precisely it strives to perfectly replicate, inevitably suffers mutational change, either by errors in replication, or by chemical damage to the constituent molecules. In the event such changes result in new advantageous features, selective advantage will result in their preservation, otherwise they will weaken the genome and tend to be eliminated.

This means that evolution is absolutely inevitable in all living organisms cosmologically. It isn't a theory, but a molecular fact and reality of the physical universe, which cannot legitimately be sidelined, marginalized or claimed to be unproven by religious arguments about creation. It is confirmed, both by the geological record and the now sequenced genetic tress of diverse living organisms, including humanity, where we have learned that we have not only descended from apes but interbred with Neanderthals and Denisovans. It has been observed in real life in a host of natural and experimental situations and is happening to us as we speak.

Once life became established, it fanned out into two broad categories, those living closer to mineral conditions became the archaea, and those interacting more closely with other organic systems became the bacteria. The archaea are now found living in extreme habitats such as hot pools, high-salt habitats and as the methanogens living in swamps and some animal intestines. The bacteria fanned out into a host of habitats, both becoming photo-synthesizers, such as the blue-green algae that rule today's ocean photo-fixation of energy and heterotrophic bacteria that invade, break down and utilize all manner of biological nutrients, including pathogenic and symbiotic forms as well as a wide variety of other habitats.

This divergence into all available ecological niches is universal to evolving living systems. Climax ecosystems require plants, and animals to fertilize them and control rampant competition, and evolution generates, along with the animals, carnivores and herbivores, parasites, predators and prey filling complementary niches. A climax predator such as a lion, despite living of killing the stragglers, is necessary to the survival of its prey, or the gazelles become liable to acute boom and bust, only to die en masse from starvation through eating out the grasslands. There is thus no moral cosmology that says the lion should lie down with the lamb. Morality is not universal to cosmology but an evolutionary property of human and animal societies, as we have noted.

The divergence between the archaea and bacteria is very ancient because the ribosomes, the RNA-based protein translating factories of living systems, are structurally distinct, placing their divergence close to the evolution of the genetic code and protein translation, and the fact that they don't share key DNA enzymes or fundamental cell wall components suggests they diverged both before RNA genomes had converted to DNA and before life had fully escaped its chemical Garden of Eden to become free-living cells.

Nevertheless shortly after its initial appearance, around 3.5 billion years ago, there was an explosion of genetic diversity, probably due to a high degree of horizontal transfer of genes between organisms, resulting in most of the key metabolic pathways we find today. There was then a long epoch of single-celled life on Earth, with the largest fossils being stromatolite colonies of bacteria, which still exist on the shorelines of parts of Australia, until around a billion years ago, another event, almost as significant as the origin of life, took place.

Eukaryotes Transform the Game of Life

Somewhere between 1.4 and 1 billon years ago, a new life form emerged out of an energy symbiosis between a species of archaea and a respiring proteobacterium. The archaeote appears to have engulfed the bacterial species, but rather than digesting it, became energized because the respiring bacterium was providing about seven times as efficient a form of energy transduction than the archeote metabolism.

There is no clear trace of the immediate precursors of this event, or exactly how several of the rapid-fire changes occurred, but we can identify the archaea closest in genetic evolutionary terms with the closest set of genes and we know that it was probably a respiring γ-proteobacterum that became engulfed. Neither are there any fossils of the immediate successors of this event still in existence because the ensuing life forms were so successful that they have wiped all immediate precursors and successors off the face of the Earth.

These new life forms are the eucaryotes, the first fully nucleated cells, which are an endosymbiosis between powerful respiring bacteria, and archaea that still retained much of the more ancient RNA-based information processing. These cells, utilizing the combination of high-energy respiration and versatile genetic processing developed the nuclear envelope, the ability to manipulate many chromosomes using centrioles and mictubule spindles in cell division, a complex internal digestive system, the endoplasmic reticulum, the new forms of motile flagella we see in human sperms to this day and all the other organelles of the modern eukaryote cell, from protists such as amoeba through to multicellular plants animals and fungi.

The critical thing is that all eukaryote cells have endosymbiont mitochondria genetically related to proteobacteria, which perform the energy-rich functions of respiration and electron transport in the eukaryote cell. Even very primitive eucaryotes such as giardia have been found to have vestigial mitochondria which have atrophied due to their anaerobic habitat, placing the endosymbiosis event right at the origin. Among the eucaryotes there are several major families, broadly divided into the unikonts (one flagellum), including amoebae, animals and fungi; and dikonts, including plants and the other unicellular groups. Plants and animals separated close to the root, so characteristics common to both plants and animals are probably also primal.

Careful analysis shows that the majority of reactive enzymatic genes in the eukaryote nuclear genome probably derived originally from the mitochondria, while the information processing nuclear genes originated from the archaeal genome. Gradually, with migration of mitochondrial genes to the nucleus, only a bare minimum of essential mitochondrial genes remain on the mitochondrial chromosome. In turn the RNA processing function of the archaeote provided a richer repertoire for gene regulation than the ultra-compact fast tightly-linked operon-based gene regulation of bacteria, and the modular functional architecture of non-coding spacers called introns which separate the functional exon regions of active coded enzymes provided for a more flexible framework for gene evolution involving modular components of genes, facilitated by the RNA processing which enables differential gene expression from the same messenger.

A species very close to the root of the eukaryote radiation is *Naegleria gruberii*, a free-living ocean organism belonging to the excavata, which include some of the most primitive eucaryotes such as *Giardia* and *Trichomonads*. Nevertheless it is capable of both oxidative respiration and anaerobic metabolism and can switch between amoeboid and ciliated modes of behavior, regenerating complete centrioles and flagellae as needed. Its genome sequence includes 'muscular' actin, microtubule cytoskeletons, mitotic and meiotic machinery, suggesting cryptic sex, and a rich repertoire of signaling molecules, which become pivotal to brain function in higher animals, including G-protein linked receptors, histidine kinases and second messengers including cAMP. One *Naegleria* strain investigated is a composite of two distinct haplotypes, indicating sexual hybridization. Although sexual mating has not been observed, the heterozygosity found in the Naegleria genome is typical of a sexual organism, with perhaps infrequent matings.

We thus see that founding eukaryote lines already had essentially all the organelle and functional components necessary for multi-celled animals to evolve, including receptors and signaling molecules necessary for nervous system function, the capacity for sexual reproduction and the full suite of genes involved in cellular architecture and motile activity.

Sex Sneaks in at Ground Zero

Sexual recombination transforms the evolutionary process in two intertwined ways. Firstly sexual recombination aligns genes resulting in natural selection being able to respond to single gene changes, rather than the major chunks of the genome coupled together in bacterial replication. Secondly crossing over means

homologous genes from the two parents are crossed over to provide novel genomes, which nevertheless contain a full viable gene complement.

This provides endless variety in the offspring, which enables them to resist catastrophic attacks from parasite organisms, as well as enabling a form of 'Muller's ratchet' preventing the gradual accumulation of mutations in a large genome to lethal levels. Resistance to parasites and diseases provides an immediate survival advantage to sexual organisms in the first generation, helping to explain how sexuality could become established before any evolutionary advantages accrued over time. Because all the offspring are genetically diverse, even if some contain deleterious or lethal mutations, some others will not and become the survivors who have eluded the mutational change. Sexuality also allows extremely rapid uptake of a new advantageous mutation, through selective sweeps, which confer a significant advantage to the reproductive power of offspring containing the new characteristic.

Contrary to the idea that sexuality and sexual recombination are late adaptions of advanced eucaryotes, investigation of meiosis-related genes produces evolutionary trees showing the occurrence of these genes across the eucaryotes from *Giardia* to *Homo sapiens*, implying sexuality is a founding characteristic of all extant eucaryotes. Forms of both unikont amoebozoa and dikont rhizaria and excavates show trends consistent with founding sexuality, later lost in some branches. Both amoebozoa and rhizaria show confirmed evidence for sexuality, such as meiosis, showing it is a likely founding characteristic.

The early origin of sexuality is attested to by research into the extended family tree of amoebae, which shows that sexuality is likely to have arisen in their common ancestor and been subsequently lost in asexual protist species. Unequivocal evidence for sex in the primitive excavate Giardia implies sexuality arose in the last common ancestor of all eucaryotes, very early in evolution, suggesting it may have been a founding characteristic of the archaeote partner in the endosymbiosis, from which most of the information processing genes are derived.

The Ancient Evolutionary Foundations of Consciousness

Excitable membranes are universal to eucaryote cells, as is the need to sense electrochemical and nutrient changes in their milieu. Edge of chaos dynamics is a natural consequence of excitability, providing arbitrary sensitivity to disturbances caused by predators and prey in the active environment. It is a function critical for survival in both single-celled and multicellular organisms. It is thus easy to see how chaotic excitability became a sensitive sense organ in single celled eucaryotes constituting a form of cellular 'consciousness' in such species.

It should also be noted that the biological sense modes of vision, hearing, smell, touch and electrical sensitivity are really the available fundamental physical quantum modes, which the electrical sensitivity of the excitable cell can help bring into play. Vision for example is membrane excitability primed by photon absorption, and the photoreceptor molecule in human vision is rhodopsin. The extremely ancient origin of the rhodopsin family of heptahelical receptors can be seen from the ultra-primitive photosynthesis in archaeote Halobacteria, which lack any form of electron transport, relying only on the direct coupling between photo-stimulated H^+ pumping and chemiosmotic ATP formation universal to life, based on bacteriorhodopsin, which shares genetic sequence homology with vertebrate rhodopsins, uses a form of retinal as in human vision, and has the same heptahelical membrane-spanning structure as G-protein-linked receptors for neurotransmitters such as serotonin, suggesting these receptors, also found in *Naegleria*, first arose in archaea.

Likewise the neurotransmitters that give us the sappy biochemical brain have an ancient origin in single celled-eucaryotes as signaling molecules. The elementary neurotransmitter types, many of which are fundamental amino acids (glutamate, glycine, GABA) or amines derived from amino acids (serotonin, catecholamines nor-epinephrine and dopamine, histamine, and choline) have primordial relationships with the membrane, as soluble molecules with complementary charge relationships to the hydrophilic ends of the phospholipids, which later became encoded in protein receptors. The serotonin 5-HT1a receptor for example is estimated to have evolved up to a billion years ago, concomitant with the eucaryote emergence. Receptor proteins, second signaling pathways and key neurotransmitters including norepinephrine, epinephrine, and serotonin occur widely in single-celled protists. Species of *Entamoeba* secrete serotonin and the neuropeptides neurotensin and substance P, a neuropeptide associated with inflammatory processes and pain in humans, and release and respond to catecholamine compounds during differentiation. The metabotropic (protein-activating) glutamate and GABA receptors likewise go back to the social amoeba *Dictyostelium discoideum*, along with the cAMP signaling pivotal in aggregation of some 100,000 partially differentiated cells on impending starvation to form an asexual fruiting body, although it is also capable of sexual reproduction.

This leads to a picture where the essential physiological components of conscious brain activity and sensory awareness arose in single-celled eucaryotes, both in intra and intercellular communication, and in the chaotic excitability of single cells in sensing and responding to their environment. These include ion channel based excitability and action potentials, neurotransmitter modulated activity based on specific receptor proteins, membrane-nucleus signaling and precursors of synaptic communication. We can thus see that the neurodynamic processes underpinning subjective consciousness are evolutionarily ancient and originate in single-celled protista long before the emergence of multi-celled animals and nervous systems.

Single Celled Societies to Sappy Nervous Systems

With the emergence of multi-celled organisms, the evolutionary features that enabled sensory excitability and social signaling became adapted to internal signaling within the organism as well as sensory receptors for the active environment. The adaptions driving this change arose in the era of single celled eucaryotes from sophisticated cells with active social signaling acting with a relative degree of autonomy to form active colonies.

A key idea about the evolution of consciousness is thus that it first evolved in single celled eucaryotes as a combination sensory and anticipatory excitation, occurring at the edge of chaos, which the cell maintained energetically to keep a sensory model of its electrical and sensory environment to detect food but above all to guard against sudden attack by predators. As this is the most pressing filter on survival of the organism and its species, anticipatory modeling of the active environment via chaotic excitation continued to be pivotal as social single celled species became colonies and then organisms, with the central nervous system becoming the key organ of anticipatory modeling by chaotic excitation, utilizing both direct membrane excitation, and the modes of molecular social signaling in the form of modulating neurotransmitters.

The coelenterate hydra illustrates a point on the transition from autonomous colony to organism. It has one of the first nervous systems, which is essentially a neural subnet pervading the tissues with no imposed central organization. The organism is still essentially a colony and if the hydra is turned inside out the individual cells of the endoderm and ectoderm can migrate and reorganize themselves to reform the active organism. Nevertheless, the behavior of the hydra is highly sophisticated. It can detect and kill prey surrounding it with stinging tentacles and drawing resisting prey into its stomach and it also has up to twelve different forms of locomotion, involving central coordination, including snail-like sliding on its base, rising to the surface on air bubbles and attaching to the surface tension, and even somersaulting onto its tentacles and rolling over to adhere again at its base. This helps make it clear that the sophistication of its behavior is very much a function of the neural plasticity of its individual neurons and the extent of behavioral programming in its genome. Serotonin signaling in ectodermal neurons is also known to cause metamorphosis in coelenterates.

The diversification of neurotransmitter receptors into the forms we find in humans today also occurred early in the metazoan radiation, with the serotonin 5HT1 and 5HT2 receptor families diverging before the diversification of molluscs, arthropods and vertebrates. All metazoan central nervous systems are also sappy, with pivotal roles for diverse neurotransmitters modulating activity through metabotropic receptors such as a vast G-protein linked family that includes all the major neurotransmitters including both amines and polypeptides and diverse sensory receptors for chemical sense including smell, as well as vision. Arthropods for example have a very similar repertoire of neurotransmitters including serotonin and dopamine in evolutionarily similar roles to vertebrates with octopamine and tyramine being used in place of nor-epinephrine. Psychedelics and stimulants are known to have behavioral effects in arthropods distinct from but related to those in vertebrates.

Looking at the roles of serotonin, dopamine and other neurotransmitters from oxytocin to endorphins in humans and their functions in mood and motivation, combined with their predilection for ‘abuse’ as recreational and psychotherapeutic drugs demonstrates that humans, although having an electrically excitable nervous system, depend on the same sappy signaling molecules to maintain their overall emotional tone and sense of motivation, direction and their survival that social signaling has achieved for single celled social species, such as *Dictyostellium*, in ensuring their survival.

The profound affects that psychoactive molecules can have on consciousness, especially the psychedelic serotonin agonists, shows there is a deep connection between this sappy biochemical aspect of brain function and major changes of coordinated activation associated with changes of consciousness that may be a key to understanding how consciousness actually arises. This association is also confirmed by the changes in brain function associated with wakefulness and sleep cycles where the onset of sleep and dreaming REM states is likewise associated with changes in modalities of excitation via serotonin, nor-epinephrine and dopamine secreting neurons in basal brain centres such as the substantia nigra, and locus coeruleus.

Consciousness and Real Time Anticipation

Running counter to the reduction of consciousness to a combination of deterministic laws and random perturbations, are approaches in which consciousness is seen as fundamental to the existential condition, and even complementary to physical phenomena and processes. The nature of this complementarity has been highlighted by the "Hard Problem" in consciousness research, - "explaining why we have qualitative phenomenal experiences, contrasted with the "easy problems" of explaining our ability to discriminate, integrate information, report mental states, focus attention, etc. Easy problems are easy because all that is required for their solution is to specify a mechanism in the brain that can perform the function. For example identifying conscious states accompanying attentive processes with higher frequency EEG signals in the gamma range. The dilemma of the hard problem implies that no purely objective mechanism can suffice to explain subjective consciousness as a phenomenon in its own right.

This leads ultimately to a cosmology in which consciousness and the physical universe are complementary. Existential reality thus presents as a complementarity paradox. While we acknowledge our subjective consciousness is somehow a product of our biological brain, which is in turn a fragile product of physical forces on a cosmological scale, all our experiences of reality, including our perceptions of the physical world, as well as dreams memories and reflections, come exclusively and totally from our subjective consciousness. This suggests that existential cosmology is a complementarity between subjective consciousness and the physical universe, in which both are fundamental.

In the veridical way existential reality is generated, subjective experience is primary. In the consensual overlap of our subjective experiences we gain a common experience of the physical world, which we then interpret as containing biological brains, which may also be able to have subjective experiences. However, attempted construction of reality from the physical universe and its brains remains incomplete, because there is no explanation of how the brains can also have subjective conscious experiences.

Subjective consciousness involves coordinated whole-brain activity as opposed to local activations, which reach only the subconscious level. Attempts to find the functional locus of subjective consciousness in brain regions have arrived at the conclusion that active conscious experiences are not generated in a specific cortical region but are a product of integrated coherent activity of global cortical dynamics. This implies that the so-called Cartesian theatre of consciousness is a product of the entire active cortex and that the particular form of phase coherent, edge-of-chaos processing adopted by the mammalian brain is responsible for the manifestation of subjective experience. This allows for a theory of consciousness in which preconscious processing e.g. of sensory information can occur in specific brain areas, which then reaches the conscious level only when these enter into coherent global neuronal activity, integrating the processing.

To discover what advantage subjective consciousness has over purely computational processing, we need to examine the survival situations that are pivotal to organisms in the open environment and the sorts of computational dilemmas involved in decision-making processes on which survival depends.

Many open environment problems of survival are computationally intractable and would leave a digital antelope stranded at the crossroads until pounced upon by a predator, because they involve a number of factors, whose computation increases super-exponentially. Open environment problems are intractable both because they fall into this broad class and also because they are prone to irresolvable instabilities, which defy a stable probabilistic outcome. Suppose a gazelle is trying to get to the waterhole along various paths. On a probability basis it is bound to choose the path, which, from its past experience, it perceives to be the least likely to have a predator, i.e. the safest. But the predator is likewise going to make a probabilistic calculation to choose the path that the prey is most likely to be on given these factors i.e. the same one. Ultimately this is an unstable problem that has no consistent computational solution.

There is a deeper issue in these types of situation. Probabilistic calculations, both in the real world and in quantum mechanics, require the context to be repeated to build up a statistical distribution. But real life problems are plagued by the fact that the context is endlessly being changed by the decision-making processes of the active players in the survival game. Finally, in many real life situations, there is not one optimal outcome but a whole series of possible choices, any or all of which could lead either to death, or survival and reproduction.

Key to the role of consciousness is that survival is often a matter of split-second reaction to foreboding, just in advance of a strike. The critical point is that consciousness is providing something completely different from a

computational algorithm, it is a form of real time anticipation of threats and survival that is sensitively dependent on environmental perturbation and attuned to be anticipatory in real time just sufficiently to jump out of the way and bolt for it and survive. Thus the key role of consciousness is to keep watch on the unfolding living environment, to be paranoid to hair-trigger sensitivity for any impending hint of a movement, or the signs, or sound of a pouncing predator - an integrated form of space-time anticipation.

It is this question, above all which consciousness evolved to resolve because the survival of the organism depends on it. This goes a good way to explaining why humans, despite having some 10^{11} neurons and 10^{15} synapses can manage only a digit span of around seven. We are superb at split-second integrated reactions but most of us are relatively lousy at numbers by comparison even with a pocket calculator, let alone a personal computer.

This immediacy is the basis of an innovative theory of consciousness. The Attention Schema theory suggests that consciousness arises as a solution to the environmental informational overload problem: Too much information constantly flows in to be fully processed, so nervous systems evolved increasingly sophisticated mechanisms for deeply processing a few selected signals at the expense of others. Consciousness is the ultimate result of this evolutionary sequence. The cortex gains its abstraction by constructing a constantly updated perspective that describes what covert attention is doing moment-by-moment and what its consequences are. This first evolved as a model of one's own covert attention, but once in place, it adapted to model the attentional states of others, to allow for social prediction. Not only could the brain attribute consciousness to itself, it began to attribute consciousness to others.

We understand other people by projecting ourselves onto them. But we also understand ourselves by considering the way others might see us. Thus the networks in the brain that allow us to attribute consciousness to others overlap extensively with the networks that construct our own sense of consciousness. And this process can become hyper-tuned defensively. It's better to be safe than sorry. If the wind rustles the grass and you misinterpret it as a lion, no harm done. But if you fail to detect an actual lion, you are taken out of the gene pool. So paranoia is the name of the game and a key to the conscious condition. This doesn’t solve the hard problem, but it does suggest a path into the centre of the cyclone. The question remains as to how the brain can anticipate reality in a universe full of chaos and uncertainty.

Fathoming the Inner Dimensions of Consciousness

In discovering the foundations of existence, understanding the inner dimensions of conscious experience forms a critical complement to the discovery of the natural universe. There is an urgent need in the cosmological discovery process for a full exploration of the diversity and depths of the conscious condition, a process that, in the scientific era, is lagging far behind understanding of the objective world, yet is completely central to the existential condition.

Subjective experience comes in a spectrum of conscious states that extend far beyond our everyday experiences of the world around us and the immediate processes of memory and reflection about our past and future waking existence. They include meditative and contemplative states, common to both Eastern and Western spiritual traditions, utilizing complex forms of visualization, one-pointedness and emptying the mind of the internal dialogue that manifests in the default circuit activation of the brain as we rehearse situations we may face in real life, also encompassing forms of sensory deprivation and trance states induced by shamanic practices of diverse cultures. These mental states show distinct patterns of coherent activation when explored using EEG and MEG. There is also a spectrum of conscious states associated with sleep, from daydreaming reverie, through deep sleep to the paradoxical states of REM (rapid eye movement) dreaming sleep, and lucid dreaming, to OBE (‘out of body’) experiences sometimes associated with semi-consciousness states or sleep paralysis. Going further, they include hallucinatory, psychotic and delirious experiences and the NDEs (near death experiences) of people in major physical existential survival crises, from heart attacks, to traffic accidents.

Finally, they include psychedelic experiences, both using synthetic drugs like LSD and natural psychedelic species, ranging from sacred mushrooms to peyote and ayahuasca, all of which have been used for millennia as ceremonial sacraments by traditional cultures to understand the inner nature of existence. Alongside dreaming states, these induce some of the most profound changes in consciousness known including kaleidoscopic visions, eo death and extra-corporeal experiences. One should also include the dissociative experiences associated with consciousness-altering agents such as ketamine, salvia and ibogaine. Cannabis has likewise been used as a sacred consciousness-altering herb, from the Ganga of the Shiva Sadhus to the Rastafarians of Jamaica.

The journey of inner conscious exploration that has always been integral to the Eastern meditative tradition, is also central to shamanic traditions of diverse ethnic cultures who have preserved a spiritual relationship with natural forces as integral to their cosmology of existence. Meditative and contemplative traditions tend to stress ordered states of mind, requiring mental control and thoughts and actions defined by the religious doctrines and beliefs of the tradition. This tends to restrict the domain of inquiry to those conscious states that reinforce the tennets of the tradition, rather than the free pursuit of knowledge and wisdom. There is thus a need to foster a full investigation of the inner and outer limits of conscious experience, in the same free spirit of inquiry that is the hallmark of scientific discovery and is the central principle guiding the vision quest.

Psychedelic and dissociative agents provide unique opportunities for exploration of deep states of consciousness that are confounding to our every day notions of the conscious condition and introduce completely new insights as to what consciousness is. They may provide the best clues we have to the ultimate question of what the actual relationship is between brain activity and conscious experience in the "hard problem".

The psychedelics have been subjected to a completely counter-productive cultural, legal, and criminal repression by Western governments, that has deep parallels to the witch-hunts and inquisition of the middle ages, in which alternative beliefs and practices were seen as an existential threat to Christianity. There is an immense contradiction, that in the scientific age, Western governments, despite knowing that psychedelic agents have been used traditionally for millennia as visionary sacraments, acted to taboo them out of a similar fear they posed an existential threat that could precipitate a breakdown in the fabric of our dependence on domestic consumer society, and so classified them as schedule one prohibited substances under pain of extreme criminal penalties for possession or supply.

I have pursued experience of the Eastern meditative traditions at their roots as well as experience of psychedelic shamanism at its sources, from the peyote ceremonies of the Native American Church, through the use of sacred mushroom species to partaking in ayahuasca ceremonies in the villages of Amazonian Peru. In my view the psychedelic path has significant advantages over traditional meditative traditions, because it is an inner journey of discovery, which is free of doctrinal assumptions and is the most direct route to a mind-expanding investigation of the foundations of consciousness available. Its effects on consciousness are both profound and provocative to the core quest to discover the inner nature of subjective experience in understanding the meaning of existence.

They also have a potentially unique relationship with our sappy neurotransmitter-saturated brain that appears to be modulating the very brain processes through which subjective consciousness is generated. Psychedelics are super-agonists of serotonin 5HT2a receptors, which appear to cause a confirmation shift which may activate associated metabotropic glutamate mGluR2 receptors, initiating a cascade of modulations to brain activity in which internal brain processes, including fractal excitations evoked by the substances, allow aspects of unconscious or sub-conscious processing to reach the conscious level.

Studies of dreaming states are also highly provocative to the discovery quest of subjective consciousness. The role of REM dreaming sleep still remains enigmatic. Although it has been associated with forms of memory consolidation and reprogramming, the amounts of REM and deep sleep in diverse mammals species remain enigmatic and highly varied. Dreams evoke existential situations, which challenge our ideas of how the existential universe is composed. Like deep psychedelic experiences, they include paradoxical states ,which it can be difficult or impossible to rationalize afterwards.

Some people also report prescient dreams which appear to become realized afterwards, leading to the possibility that the dream state may be a key to understating how conscious anticipation relates to time and space. They are also part of the continuum, in the dreamtime, of a collective, or empathic, consciousness between widely separated individuals who may be closely related or intimate partners.

The key to exploring the subjective condition more deeply may be that rather than seeking verification from others, we can each discover for ourselves in the first person the deeper nature of our conscious existence and only then come together to compare notes and establish a cultural consensus of what these states contain and imply. These are all questions which take us to the boundary of where verification and proof become contradictory to the subjective nature of the realm being explored, just as we have seen with the escalating forms of indeterminacy in the quantum universe, leading to the potential roots of both enigmas.

Unfolding the Multiverse

So where does this journey take us in terms of how conscious experience links back to changes in the world around us that make the changes in history we associate with meaning and purpose? What is the actual relationship between consciousness observing and subjectively acting on the physical world and changes in the world itself?

We have noted that the interactive cosmological process set off by the symmetry-breaking of the forces of nature culminates in molecular matter where all the forces gain expression in order of their interaction strengths, and that this process doesn't stop at individual bonds, because weaker H-bonds, polar and non-polar interactions, and van der Waal forces act cooperatively to make molecules into fractal structures leading to molecules such as proteins and nucleic acids with complex tertiary structures, cellular organelles, cells, tissues, organs and organisms, with the ultimate interactive culmination being the conscious brain. The ultimate seat of consciousness in the universe thus lies in the biota and nowhere else. The buck thus stops with us. There is no other place, from the gravitational core of black holes through the nuclear furnaces of stars to the cold outer reaches of galactic dust clouds that interactive complexity reaches its ultimate culmination. Thus we can be relatively certain that consciousness lies pivotally in the biota of the universe and that any pretensions to a conscious divinity in the heavens are a delusion just as a heaven in the clouds populated by winged angels are fantasies. Without being in any way anthropocentric, we can thus realize that the conscious brain is the ultimate interactive expression of the forces of nature which broke symmetry in the big-bang – paradise on the cosmic equator becomes our conscious condition and our living responsibility to fulfill in protecting the living diversity of the planet, in the closing circle of the biosphere, for the conscious generations to unfold into the living future.

So we finally trace our journey back to discovering how intentional will may be able to alter the course of physical history, giving us the means to apply our conscious awareness to change the world and to sustain and replenish it for life to follow.

Two experimental studies supporting the observer having a critical role in collapse of the wave function include the delayed-choice quantum eraser. The quantum eraser is an arrangement of entangled particles where we can separate them in such a way as to make a quantum measurement, but can then subsequently re-unite them in such a way that the collapsed measurement is erased. In the delayed choice quantum eraser, this process occurs by an observer after the quants have traversed the apparatus.

The experiment uses a careful arrangement of detectors generating a particle pair which are simultaneously entangled with another pair whose paths are only detected later which then pass through a detector which cannot distinguish their paths, leading to a superposition. However the later detection of their entangled siblings in a manner which can also be subsequently erased shows that it is the observers later knowledge of the pair, not whether there was a detector at one of the slits that determines collapse.

A second experiment involves delayed-choice entanglement swapping. Here, entanglement can be produced after the entangled particles have been measured and may no longer exist. A third observer by making a choice of detector determines which arrangement two other observers experience of an entangled pair, shows decisively that a change induced by a third-party observer can alter the (earlier) observation of an entangled pair.

Thus a critical role of subjective consciousness may be that it is a way the universe can solve the super-abundance of quantum superposition probability multiverses where the cat is both alive and dead, to bring about a natural universe in which some things do happen and other things don't. Hence the title ‘unfolding the universe’ through consciousness collapsing the wave function because history is unfolded by consciousness collapsing the multiverse.

One of the most central experiences of our lives is that there is a line of actual history, in which each of us is embedded and in which we are able to change the world in ways that we consciously intend. However insignificant our lives, we are participating in bringing the world into actual being historically. This means that the passage of the generations is able, through making decisions about our lives and the circumstances around us, as well as ensuring our own survival is at the same time discovering ourselves more deeply as conscious beings, in reaching towards a state where the universe comes to consciously understand itself ever more deeply and completely.

The notion of the brain using entanglement provides a paradigm for resolving many of the contradictory situations that arise when classical causality is applied to anticipatory processes. A premonition being either a cause of a future event or caused by it leads to contradiction, which is resolved in the space-time hand-shaking of the entanglement shrouded in quantum uncertainty.

The process goes something like this: Memory systems are used to form a model of the quantum collapsed history already experienced, which is sequentially stored in the hippocampus and then semantically re-encoded into the cortical feature envelope, so that it can be interrogated from any contingent perspective in future. The conscious cerebral cortex contains a dynamical system of entangled states, which together envelop a space-time region extending a limited distance into both the past and future - the quantum-delocalized present. The cortical envelope thus maintains a state of context-modulated sensitively-dependent dynamic excitation which generates our conscious sense of the present moment by encoding the immediate past and future together in a wave function type of representation entangled within discord in the globally coherent dynamic.

The quantum present would extend over the lifetime of the coherent excitations, incorporating quantum-encrypted information about the immediate past and future of the organism into the current state of subjective experience. The quantum present provides the loophole in classical causality that permits intentional will to be free enough to perturb unstable and hence formally unpredictable brain states and hence physical states in the world, through our behavior. The experiencing subject perceives they are making an autonomous decision. An external observer will simply see a brain process sensitively dependent on quantum uncertainty bifurcating into a defined but unpredictable outcome.

It may also be possible for the brain to encode entangled states in more permanent forms. Highly active brain states have been shown in fMRI studies to elicit changes in cerebral activation lasting over 24 hours. Long-term potentiation and memory processes are in principle permanent and may involve epigenetic changes.

The notion of the conscious mind acting on the body to induce actions and complex behavior has been described by founding brain researchers, from David Eccles to Roger Sperry, as an 'act of psychokinesis.' Eccles followed Karl Popper's triune notion of a three-aspect cosmos in which mental experiences and decisions, physical systems composed of quantum and molecular structures, and abstract knowledge, form three interacting components. Initially Sperry agreed with Popper and Eccles, like them, rejecting materialism and reductionism about the mind and brain. In 1966 he began referring to himself as a "mentalist."

Sperry's idea of emergent downward causal control gave the subjective experience of consciousness (regarded as an emergent property of brain activity) a causal role in the control of brain function. While this was still a causal deterministic model and did not involve quantum uncertainty, it did centrally involve mind as experienced by the observer acting on matter in the form of physical brain dynamics. Investigating split brains, Sperry found what he considered science-based examples of ideas, not just chemical events, running the show. From this he developed the idea that the conscious mind and the physical brain were really part of "a single unified system extending from sub-nuclear forces at the bottom up through ideas at the top. Mind and consciousness are put in the driver's seat, as it were: “They give the orders, and they push and haul around the physiology and the physical and chemical processes as much as or more than the latter processes direct them.”

What this meant to Sperry was that free will, and responsibility, were no illusion. "It is possible to see today, an objective, explanatory model of brain function that neither contradicts nor degrades but rather affirms age-old humanist values, ideals, and meaning in human endeavor" - the notion that we are autonomous conscious beings capable of exerting a mental control over our own and other people's fates. We can see that quantum uncertainty and chaotic sensitive dependence do provide a loophole for mental decisions to induce physical outcomes in the form of a bifurcation of an unstable brain state, which from the subjective point of view, is perceived to be the conscious experiencer coming to a decision under salient circumstances and choosing a course of action, which is then played out in brain function, and ultimately physical behavior.

A theory which is in effect a description of how the entanglement within the cosmic wave function might contribute to a fundamental form of free-will has been proposed by Scott Aaronson, who advocates the unpredictability description of free-will and uses it to develop a description of the universe explaining how the early universe may have given rise to unpredictable degrees of freedom which could open another quantum basis for free-will:

I advocate replacing the question of whether humans have free will, by the question of how accurately their choices can be predicted, in principle, by external agents compatible with the laws of physics.

He cites a form of unpredictability, which is more fundamental than mere statistical uncertainty, which he calls "Knightian freedom" after the economist Frank Knight, who wrote about uncertainty that can't be quantified with probabilities. The presence of such "freebits" with quantum-mechanical degrees of freedom preventing their cloning makes predicting certain future events - possibly including some human decisions - physically impossible, even probabilistically and even with arbitrarily advanced future technology. Our ignorance about the freebits would ultimately need to be traceable back to ignorance about the microstate of the early universe. Thus it's possible that humans will never become as predictable as digital computers, because of chaotic amplification of unknowable microscopic events.

Another cosmological description by Martin Green involves a hidden "Bare World" which he sees as the ultimate reality. The Bare World precedes all ordinary notions of the "Real World" that people perceive and study in physics. The Real World emerges from Bare World as a description dressed up in Newtonian, Einsteinian or quantum clothing. Observers, matter, and time, all come into existence within Real World. None of these exist within pre-physical Bare World. It is the "foundation for all that might ever be perceived in the universe". Since it contains much more information than Real World can ever accumulate, the laws of Real World do not constrain Bare World from introducing surprises. Human free will is therefore not constrained by the laws of physics - which simulate, and thus represent, aspects of emergent reality and apply only to Real World, not Bare World. Free will is a manifestation of the ability of conscious observers to influence the order in which previously unknown information about Bare World is consistently incorporated into their reality.

The Participatory Cosmos

We actively participate in our perceived reality. We control our bodies and the world we inhabit sufficiently to collectively investigate, formulate, record, and debate fundamental ideas regarding the world. We refine our models by acting on the world and sensing its response. And so the future is not strictly determined by the past. Humans can shape it. Within bounds - consistent with our limited present knowledge, a prohibition on revising history, and severely limited scope and capacity - we are able to consciously influence our future.

Contrasting with the perception that we can act independently on the world is the obvious requirement for mutual consistency of the perceptions of all observers. Such consistency can be understood only if consciousness is actually a single, global phenomenon.

But just how far does the notion of mental causation go? If we can exert psychokinetic control over our arm movements to give the thumbs up to personal autonomy, or just to wave out to a friend, are there potentially other manifestations of this mental-physical interaction?

The lessons of entanglement as a possible central process in anticipating threats to survival extends readily to other such effects, but at the same time places potential limitations on their action. The key lesson of pair-splitting experiments is that, while entangled states are correlated, we can't use them to send locally-Einsteinian causal information between the entangled components. Thus we might well find ourselves having an ad-hoc evolutionary survival advantage through our conscious experience, while never being able to prove this in a set of causally verifiable experiments.

By the same token any other effects of mental causation on material phenomena would not be causally controllable because, although changes to the entanglement arising from a mental decision might ramify throughout the cosmic wave function, a change in one component, i.e. one's mental state, cannot necessarily be used to causally induce some other physical manifestation, because of the barrier to causal determinacy in the entanglement.

This could mean that our mental decisions might potentially have other effects, both on other people’s mental experiences, and on diverse physical states in the universe across space-time, but not necessarily in a way we can determine or demonstrate conclusively. Thus notions of mental action, from telepathy and prescience to poltergeists and other 'super-natural' phenomena, would remain unverifiable anecdotal occurrences, which could not be replicated scientifically to produce an experimental verification of a causal effect.

This however does not mean that we should conclude that all such phenomena are ephemeral or non-existent and that such non-ordinary phenomena are just wishful fantasies. The evolutionary emergence of conscious sentience in organismic brains itself suggests that seemingly materialistic interactions among genetic and other molecules in simple living systems have somehow given rise to an emergent phenomenon having existential

status even more immediate than the material phenomena from which it emerged, since we access the material world only through our conscious sensory experience.

I have had during my lifetime several riveting experiences of prescience, which generated my interest in the question of space, time and consciousness. In the 1920s, J W Dunne wrote a book “An Experiment with Time” outlining a double blind experiment where he found subjects dream records tallied as closely with future as with past events. Shortly after reading the book, I had a double nightmare that I was being stung and told my wife about it when she got up to feed our infant daughter. About an hour later I was stung wide awake by a wasp that flew in the window she had opened after getting up.

A month before the Twin Towers were bought down in the 9-11 catastrophe, I composed a song, which contained words uncannily prophetic of the events “Can we fly so high we’ll pass right to the other side and never fall in flames again” … Then I watched live in prescient horror as one of the two planes struck the tower and passed right through, coming out in a burst of flames on the other side. The lyrics include a lament for the dark canyons of lower Manhattan 'walking in the twilight, down in the valley of shadows … when will you comprehend the damage you have wrought in your indiscretion, can we undo the death trance you have set in motion?' The last line closed with 'Can we bear it all again?' It thus presciently echoed the Mayor of New York Rudi Giuliani’s words on TV 'This will be more than any of us can bear”.

Critics of such influences cite Bayes theorem on conditional probabilities, claiming people who see such effects are selectively picking the times when something appears prescient while ignoring the many other situations where nothing happens, which effectively reduce the probabilities to chance. My own experience contradicts this claim. Both the two examples above were verified in real time by reporting the dream and by publishing the lyrics and the latter is too climacteric an event to reduce to Bayes formula in anyone’s mind. Nevertheless I don’t ‘believe’ in prescience either, I just live in the unfolding reality and watch carefully, using whatever subtleties I can summon to further my own survival and understanding of the world.

Biogenesis likewise remains an enigma whose processes, from simple high-energy molecules such as HCN, through RNA and proteins, to the first organisms depends on emergent properties hidden in the non-linear interactions among the four forces of nature that occur at the quantum level. The same goes for many of the emergent properties in the evolutionary epoch. Evolution, while we conceive it as a molecular process of conservation and mutation of genes, is also threaded through the life and reproductive investments of participant organisms and in the context of higher animals in all the (conscious) decisions they make to the extent that what appears to be simply an adventitious molecular dance improbable in the extreme, a little like a monkey playing Beethoven's Moonlight Sonata, is an emergent manifestation of a universe coming to know itself ever more deeply in a redemption of the mechanistic fallacy that we are merely a meaningless collocation of atoms.

Likewise the evolution of emotional experience and expression in mammals has given rise to a new paradigm in sociobiology leading to human culture, which broadens the narrow genetic bases of genetic selfishness, moderated by kin and reciprocal altruism into a complex social interplay of nuanced extremes from love to hate, happiness to despair, intimate trust to jealousy and paranoia, contempt, anger, disgust, fear, excitement, intimacy, compassion, forgiveness and all the social interactions they provide, giving not just humans but mammals generally a more oceanic form of social participation. Despite the seven deadly sins and our reluctance to be ruled by our worldly desires, and our susceptibility to sometimes coercive moral eschatologies, it is precisely these emotional nuances that have made the world a place in which love and caring form a basis of resolution of our belonging in an often perilous world of tooth and claw, and it is the higher virtues of these emotions which people define as the guiding light of spiritual illumination.

Central in this resolution of our sense of meaning and purpose is preserving the diversity of life and the robustness of the biosphere, so that that the future generations of life and humanity can prosper and further expand the vistas of conscious experience. We have already reached a level of awareness where we can grasp the cosmological dilemma, but this is not the end of the road and we need above all to be compassionate to the life which follows our own demise and for the genetic diversity which has taken a third of the universe’s own lifetime to manifest.

It may be that the very conscious decisions we make as individuals, not only through our survival and reproduction, nor just the examples they set for others and the knowledge they provide us all in the cultural epoch, but also through the unseen effects of the entanglement, extending far and wide through space-time, may be a key part of the way the universe as a whole comes to unfold its capacity for knowing. This may both aid the

flowering of life in the universe over time and a deeper meaning in space-time that stands, even when the Earth, the human race and our future forebears, become extinguished in the nemesis of the solar system as the sun transforms into a red giant, or on a cosmological scale, as the universe itself enters the eventual big crunch, or heat death.

In this sense, what is achieved may ultimately be achieved eternally in space-time by having occurred at some phase in the life of the universe, rather than life gaining meaning only because it will lead to further exponentiating outcomes in future. In a fundamental sense, space-time is both eternal in the relativistic reality and temporal in the quantum events that unfold. Consciousness appears to be able to capture both these aspects and in its cosmological manifestation may be as eternal as the quantum universe is temporal.