

## Quantum Miracles and Immortality

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**Abstract:** It has become common in transhumanist circles to claim that quantum physics implies some kind of proof of immortality, of one kind or another. While these claims are met with widespread scepticism, there has been relatively little attempt to analyze them carefully. I critique some of these, and related, claims about quantum mechanics, from the perspective of algorithmic information theory, showing that they are mostly fallacious, due to reasons of thermodynamic instability. While some of the more minor claims are shown to possibly have substance, the claimed effects are not publically verifiable.

### Introduction

Are miracles possible?

Do we have a soul?

Can we live forever?

It is widely believed that such old-fashioned questions have been rendered absurd by the materialism of modern empirical science, but some seemingly 'magical' properties of quantum mechanics have brought them back into serious discussion in some circles. I will examine the possibility of making miracles using well-established principles of quantum mechanics—in particular, the possibility that quantum theory allows for the most desirable 'miracle' of all: immortality.

We will discover that 'major miracles'—those that appear to violate the laws of classical physics—will turn out to be almost certainly impossible. But 'minor miracles', which do not violate physics, but merely beat the odds—such as guaranteeing a win in the lottery—*can* be generated with some reliability.[23] Unfortunately, the win is risky and comes at a great cost, one you are not likely willing to pay.

I will also examine the rational basis of arguments for the immortality of the soul based on quantum mechanics, particularly those of Perry [18] and Tipler [25]. I will conclude that there are problems with such proofs so, although intriguing, they must currently be considered inconclusive.

In spite of this negative result, we will find that *minor* quantum miracles have a more conclusive impact on our prospects for achieving immortality—but through natural means such as advanced medical technology. For if it seems that such medicine will not be developed in time to save you from death, you can still have your body cryopreserved at low temperature, immediately after legal death. If you are lucky, you will be thawed out and revived in the future, when the requisite technology to grant you immortality has been developed. We will see that quantum mechanical effects can radically improve your chances of being successfully revived from cryopreservation.

## **2 Assumptions**

Every argument begins from some set of assumptions. While many of my assumptions can be justified in terms of more general rationalist principles, I do not have the room to do that fully here, so feel free to treat them as independent assumptions if you wish. See my other writings for a more complete defense.[8][19][20][21][22]

### **2.1 Assumption #1: Scientific Rationalism**

I will assume, until given evidence to the contrary, that the natural world is a result of rationally understandable processes. I will only admit entities not amenable to rational analysis if rational analysis fails to explain the empirically observed phenomena, and even then I will keep looking for a rational explanation for whatever remains unexplained. I will accept that the scientific

method is the means by which natural phenomena are to be investigated, and will always accept the logically simplest theory that best explains our empirical observations, until such time as empirical observation mandates modification of the theory. The 'simplest' theory will be defined as the one with the fewest rationally unjustified assumptions.

Scientific rationalism means accepting, at least as a working hypothesis, that our most highly corroborated scientific theories are *literally true of the world*. This may sound like a no-brainer, but many scientists and philosophers (particularly extreme empiricists and positivists) are too timid to do this when said theories violate their common-sense view of the world. In what comes, we will take the best that science offers us, and we will take it seriously, come what may.

## **2.2 Assumption #2: Computationalism and Strong Artificial Intelligence**

The 'Strong Artificial Intelligence Postulate' (Strong AI) is the hypothesis that consciousness is a result of purely mechanistic, rationally comprehensible processes, *and nothing else*. More specifically, it assumes that such processes are exactly those that can be simulated on a computer with an inexhaustible memory and unlimited time.

Defining the 'soul' as a person's essence—that which makes them who they are—we can say that Strong AI rejects *both* the materialist theory of the soul, as well as the Platonic-Augustinian view of the soul as a mystical entity that defies rational analysis. Instead, Strong AI adopts the Aristotelian-Thomistic view of the soul, as the 'form' of a conscious being. The form of a thing is, in modern terms, the in-form-ation required to completely describe (or simulate) the thing. The formalistic conception of the soul was the most widely accepted view of the soul in the

Roman Catholic Church at the end of the Middle Ages. The Christian doctrine of resurrection of the body is based on it: God can resurrect you because he is omniscient and knows your form.

I will assume a rationalist version of the Strong AI Postulate, and so will further state that computational processes are strictly speaking the *only* rationally comprehensible concepts, and thus 'rationally comprehensible in principle' literally *means* 'can be simulated on a computer with inexhaustible memory and unlimited time'. This is a common rationalist assumption, closely related to the Church-Turing Thesis [3][26], although I will not attempt to further justify it here (but see, for instance, [5][6]).

### **2.3 Assumption #3: The Many-Worlds Interpretation of Quantum Mechanics**

Quantum mechanics is (along with General Relativity) our best theory as to how the world works. If our understanding of the universe is to progress, we *must* take our best theories seriously. I will therefore adopt a completely literal interpretation of quantum mechanics, and assume that the mathematical formalism of the theory literally describes objective reality. This means applying the laws of quantum mechanics *at the level of the entire universe*—for if the theory is true, it applies to the universe, and to everything in it, as much as it applies to subatomic particles.

A quantum system or object is described in quantum mechanics as many simultaneous possibilities existing at the same time, called a 'superposition' of states. Thus, the universe as a whole, if it is taken to be a quantum mechanical object itself, is necessarily a plethora of many different 'worlds' or possible world histories. This is the 'Many Worlds Interpretation' due to Everett, Wheeler and de Witt.[9] Whenever an observation is made, where more than one

possible outcome is listed in the superposition, *all* outcomes actually happen, each in a different world or universe.

Consider the classic Schrödinger's Cat thought experiment: a cat is placed in a 'black box' that is completely isolated from the environment. A small sample of radioactive material, with a 50% chance of emitting radioactive decay within the next minute, is placed inside the box. Included is a detection device set to act for exactly one minute, which if triggered by radioactive decay will break a vial of poisonous gas, and kill the cat. If the sample does not decay, the cat lives.

Quantum mechanics demands in this experiment that all possible outcomes happen simultaneously, in a superposition. Superposition is uncontroversial for electrons—for instance, the experimental evidence indicates that electrons can be in more than one place at the same time. But the notion that cats and people can be in superposition defies common sense. Yet, this is what the equations of quantum mechanics demand, if they are to apply to cats and people, as well as electrons.

Thus, when you open the box and look inside, since *you* are also just a quantum system, the entire cat+box+you system evolves along two simultaneous histories, in superposition, one with your looking in on a live cat, and one with your looking in on a dead cat. In other words, you have 'split' into two versions of yourself. You are in a sense in two separate 'worlds', one where the cat dies and one where it does not.

I will accept the Many Worlds Interpretation without further justification. For more, see [7][10][19][20][21][22].

#### **2.4 Assumption #4: Strong Anthropic Principle**

It is well known that there are many facts of nature—events in the early evolution of the universe, the values of numerous physical constants, and so on—that seem 'custom-designed' for a universe in which life evolves. Change the mass or charge of the electron, for instance, and life as we know it cannot evolve. Change the nature of the early expansion of the universe shortly after the Big Bang, and you do not get the galaxies and stellar systems required for life. In short, the universe seems somehow 'made for us'. The idea that the universe must be such that life, a priori, had to evolve is called the Strong Anthropic Principle.[1] A version of this principle uses the Many Worlds Interpretation to explain this suitability to life: we are in a world suited to life because all worlds exist, and statistically some were bound to evolve life. And we certainly could not have found ourselves in any other kind of world. This is the 'Many-Worlds Anthropic Principle'.

### **2.5 Assumption #5: The Synthetic Unity of Consciousness**

If my soul is nothing but information or computation, as Strong AI declares, then there is no reason why *two different instances* of this computation would not equally well *be* me. Or three such instances. Or a million. If my soul is computational, like a program on a CD, then it can be copied like a program on a CD. And a copy running on a different computer is still the same program.

Let us say that a copy of my soul (i.e. the information required to reconstruct my mind) is recorded on a CD a moment before my death. A hundred million years in the future, the CD is excavated by alien archaeologists, who use it to build a robotic replica of me. The replica has mental states that seem (to the replica) to immediately follow from the final mental states of my

original life. It remembers being me. It has my personality, my quirks, my memories and predilections. For all intents and purposes, it *is* me.

Thus, if my consciousness is nothing but information, it has no need of spatial or temporal continuity in order to cohere. There is no reason, then, to suppose that the various mental states and perceptions that make up my consciousness need be near each other in space and time. In fact, they might be in separate rooms... or countries... or centuries... or universes.

Going further, since we have concluded that information/logical form/mathematical structure is all that really constitutes who I am, we have *de facto* rejected metaphysical materialism—the idea that matter (and/or energy) is the most fundamental level of explanation for the universe.

While matter may be fundamental to our view of *our* world, if that world is just a statistical pick from all computations or logical structures that contain life, then it is information or logical form that is really fundamental, not matter. While many advocates of Strong AI and rationalism still call themselves 'materialists', it would be more accurate to say that they are 'computationalists' or 'mechanists', given that they take computation or information to be a more fundamental level of understanding than matter and energy.

This anti-materialism may sound to some like mysticism, or a belief that the universe is mental in nature, but this would be a misconception. Take, for instance, the Statue of Liberty, which we usually consider to be a physical object distinct from its surroundings. But scientific materialism leads us to consider that it, and the water, earth and buildings around it, are, on a more fundamental level, just a collection of electrons, quarks and other fundamental particles, arranged in a certain way. Thus, our perception of the Statue as a distinct object is a result of our limited perceptual abilities, not an absolute feature of the world. One might imagine having

super-eyes and actually seeing the individual quarks and electrons in the Statue and its surroundings. Then one could choose to view it as a distinct object, or see it and its surroundings as a whole (as a huge collection of particles, perhaps, or as a conjoined Earth-Statue object). And there are no doubt innumerable other ways we might perceive the situation.

No one would claim that this means that the Statue of Liberty is fundamentally mental in nature, or a mere illusion created by our minds. It is rather its separation as distinct from its environment that is a projection of our minds. Likewise, the computational metaphysics that we have now arrived at does *not* take our entire world to be mind-created, but *does* take it to be but a slice out of the totality of all logical possibility. Just as the Statue of Liberty is merely *perceived* by us, due to the structure of our minds, to be a distinct material object, so our whole world is only *perceived* by us as distinct from the rest of logical possibility. It is not only the Statue's distinctness from the world that is a product of our perspective, but its separateness from other worlds and other logical possibilities is likewise due to our perception and the structure of our minds.

At this point, we have arrived at a computational version of Kant's transcendental idealism: physical objects and the spacetime they inhabit are dependent on our minds for their existence *as physical objects*... their unity *as physical things is* our unity as conscious beings. They are ultimately (metaphysically) computational, but they are physically mental in nature. Kant would say they are 'empirically real' and 'transcendentally ideal'. [11, pg. 44]

Kant called this principle the 'Synthetic Unity of Consciousness' [11, pg. 153-171] (he used the term 'apperception' rather than 'consciousness', but the meaning is the same). In numerous variations, it has been re-invigorated by the popularity of Strong AI and the Many Worlds



Anthropic Principle, from which it might even be considered a natural consequence. By calling the unity of one's consciousness 'synthetic', Kant essentially meant that it was dependent on perception—it is a matter of perspective rather than objective fact. I credit Kant with the concept because he was the first to give it a rigorous formulation, but others before him had related notions of consciousness or personal identity, such as Locke [14, II.27], and as far back as Parmenides [16-17, DK28B6], who lived in the sixth century, BC. Kant's version of the idea was not specifically computational. My computational version combines Kant's Synthetic Unity with Strong AI. The two ideas together, I will call the 'Computational Unity of Consciousness'.

The quantum proofs of immortality that I will examine later all depend on some version or other of the Synthetic Unity of Consciousness. Tipler argues for computational synthetic unity.[25, pg. 210] Perry uses something very similar [18, pg. 158-189], although he seems at times to stop just short of full Synthetic Unity, holding out for an ultimately materialist substratum underneath (but one might arguably say the same thing about Kant).

## **2.6 *Algorithmic Probability: Least Complexity Required For Consciousness***

Given our computational metaphysical assumptions, the basis for any probability calculations on the quantum wavefunction must be in terms of computation. Therefore, I will assume that the probability of an experience contained in the wavefunction ultimately corresponds to Kolmogorov or algorithmic complexity [2], which is the number of bits in the shortest possible program that can simulate the experience. The Kolmogorov complexity is also identified with the 'information content',  $I$ , of a system:

$P(e)$  = the smallest program that simulates  $e$ .

$I(e) = |P(e)|$  = the size in bits of  $P(e)$ .

My world or universe is therefore the shortest program (or programs) that can simulate my conscious experience. We cannot say a priori whether such a program will also simulate rivers and trees and planets and galaxies, along with my mind... but if the Computational Unity of Consciousness holds true, then we know that it does by simple empirical observation. The physical objects around me do not seem to be transient thoughts or figments of my imagination, but seem to have stability and law-like behavior over time. Thus, we assume that the complexity of the universe around us is the least that it needs to be, in order to produce us. We could call this the Principle of 'Least Complexity Required For Consciousness'.

There is an exact correspondence between statistical mechanics, thermodynamics and information theory [24] that associates the logarithm of the information content,  $I$ , with the probability of the program,  $P$ :

$$I(e) = -\log_2 p(P(e))$$

$$p(P(e)) = 2^{-I(e)}$$

The second equation is just a rearrangement of the first. For those unfamiliar with logarithms, since  $2^3 = 2 \times 2 \times 2 = 8$ , we say that  $\log_2 8 = 3$ . This means that if the shortest possible form of a program is 3 bits long, its probability in the space of all programs is  $2^{-3} = 1/2^3 = 1/8 = 12.5\%$ . A program with an information content of 4 bits would have a probability of  $1/16 = 6.25\%$ . The more bits it takes to encode a program, the less probable it is (the less likely we would be to pick it at random from the set of all possible programs).

### 3 Quantum Miracles

Any (consistent) experience you can dream up exists in your wavefunction. For instance, there is a slice of the wavefunction where all the gas particles in the room you are now in suddenly rush into a corner of the room, suffocating you. This violates the classical laws of thermodynamics, but it happens in such a tiny percentage of universes, that the chances of our observing it are mind-bogglingly tiny. There is also a universe where random molecules in the room spontaneously organize into a million dollars in gold, or a hot fudge sundae, or a flying pig. There is another universe where they congeal into a virtual reality (VR) machine that makes you *think* you see a flying pig. And there is yet another one where the molecules in your brain organize themselves so as to make you hallucinate a flying pig. But all these highly contrived possibilities pale in comparison to the vast majority of universes, where you continue to breath the air molecules in the room, and nothing unusual happens at all.

So the question arises: can we not do something to change the probabilities so that the more desirable alternatives become more probable? I will call such feats 'miracle-working', since we are trying to violate our *usual* notions of what is physically possible. I will define 'miracle' as any apparent violation of the classical laws of physics (meaning the laws of physics as understood before the advent of quantum mechanics in 1925). I will distinguish between several types:

*Micro miracles*: miracles that are on too small or restricted a scale to have any productive impact on our everyday lives, compared to what was understood to be possible classically.

*Macro miracles*: miracles that have the potential to impact our everyday lives in a productive way. Of these, I distinguish between two further subtypes:

*Minor miracles:* macro miracles that do not appear in themselves to violate the classical laws of physics, but which radically shift the probabilities of events in a way not allowed for classically.

*Major miracles:* macro miracles that appear to violate the classical laws of physics.

Micro 'miracles' are realized all the time in physics labs. Electrons, for instance, are observed to be in a superposition of states (the superposition is not directly observed, but implied by repeated experiments). Hence, electrons can do weird things like 'quantum jump', changing their position without passing through the space in between. Our purpose here is to determine whether micro miracles can somehow be scaled up and turned into macro miracles.

The magic that is practiced by various religions and cultural traditions is usually focused on macro miracles, since these are the ones that can change our lives for the better. Modern magical practices, such as Wiccan witchcraft and Christian prayer, are usually focused on minor macro miracles. In medieval times, ceremonial magicians were more apt to attempt major miracles.[12] For example, a magic spell that brings love or allows me to win the lottery would be a minor miracle, since nothing that happens would appear in and of itself to violate physics. A levitation spell or invisibility cloak, on the other hand, would be a major miracle.

A 'quantum miracle' is any miracle that is due to the nonclassical effects of quantum mechanics. We will now look at some macro quantum miracles (both minor and major), and see whether there is any feasible way to produce them.

#### **4 Minor Miracles**

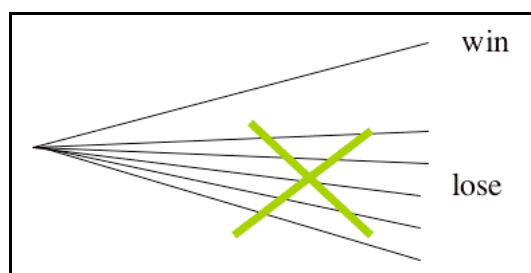
Let's say you are playing a lottery with a 1 in 10 million chance of winning the jackpot. The universe where you win clearly exists in the universal wavefunction, even shortly before the

draw. Lottery numbers are usually chosen by a machine that mixes up a lot of small balls with numbers written on them—a process that physicists call 'chaotic', meaning that a very small quantum uncertainty will very quickly make a difference at the macroscopic level (as with Schrödinger's Cat). Hence, all possible lottery numbers are about equally probable right up to some time fairly close to the draw.

Thus, after the draw, you exist in innumerable worlds, in only one ten millionth of which you are the big winner. To generate a minor miracle, you want to increase the probability of winning from  $1/10,000,000$  to something reasonably close to 100%. There is at least one way to do this, but first allow me to insert the following disclaimer:

*The following technique for performing minor miracles is strongly recommended AGAINST. It is a philosophical thought experiment only, intended to stimulate intellectual discussion. It would be extremely unwise to actually do it, and I take no responsibility for anyone unbalanced enough to try.*

Having said that, here is the technique: simply kill yourself if you do not win the lottery! The best way to do this would be to have a machine automatically monitor the lottery results, perhaps from a Web site. You then go to bed before the draw, and have the machine quietly perform the execution while you sleep. Since you are never conscious or aware in the universes where you lose, they are automatically no longer part of your physical wavefunction. You can only awake in a universe where you have won.



### **Figure 1. Minor Miracle: Winning The Lottery.**

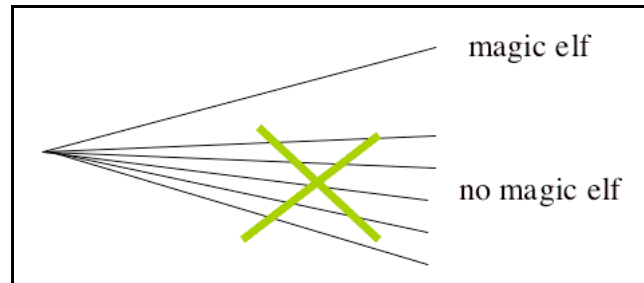
There are several really good reasons not to go out and do this! First of all, do you really have enough faith in Many Worlds to bet your life on it? I certainly do not. Secondly, even if you could be 100% certain of the theory's truth, you had still better be very sure to do your probability calculations properly, and that you set the procedure up properly. If you mess up, the result will not be millions of dollars, but a failed suicide attempt that may leave you crippled for life (we will see in a bit that this is actually the most likely outcome of any attempt to actually perform the lottery miracle).

One annoying (or pleasing?) consequence of this method for minor miracle-working is that it is only verifiable to the one who performs it. From everyone else's point of view, you have not changed the odds of winning the lottery *at all* by killing yourself. They see a dead corpse in 9,999,999 out of ten million of the universes.

## **5 Major Miracles**

Now that we have devised a method for minor miracle-working (even though the results are unverifiable to others), we will try to apply the same technique to create major miracles. Let's say I wish to invoke a tiny magical green elf to appear before me in a puff of smoke. This possibility necessarily exists somewhere in the wavefunction, just as did the lottery win. The only difference is that the probability is even lower—a difference in degree, not in kind. Thus, I ought to be able to apply the quantum suicide trick, killing myself in any universe where a tiny green magical elf does *not* appear before me in a puff of smoke. This time, I will use a human accomplice to detect the presence of the magic elf while I sleep, since the detection procedure will probably involve physical examination, interviewing, testing of the elf's magical

competence, and so on. The test of minimum magical competence will be the elf's ability to appear out of nowhere in a puff of smoke.



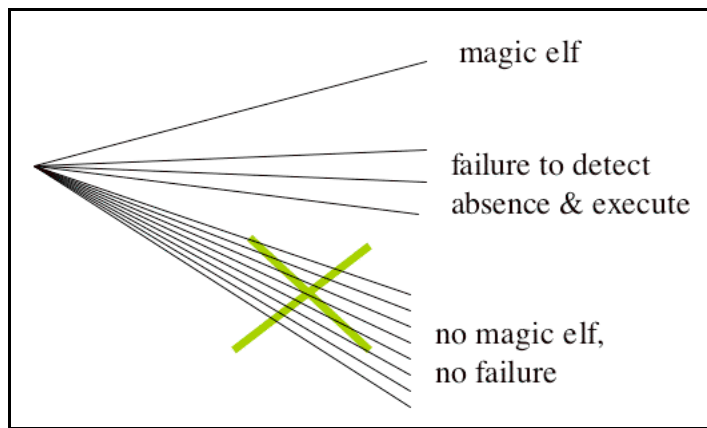
**Figure 2. Major Miracle: Invoking A Magic Elf.**

Unfortunately, there are numerous difficulties with this scheme, which we will now examine.

### 5.1 *Reliability of Detection*

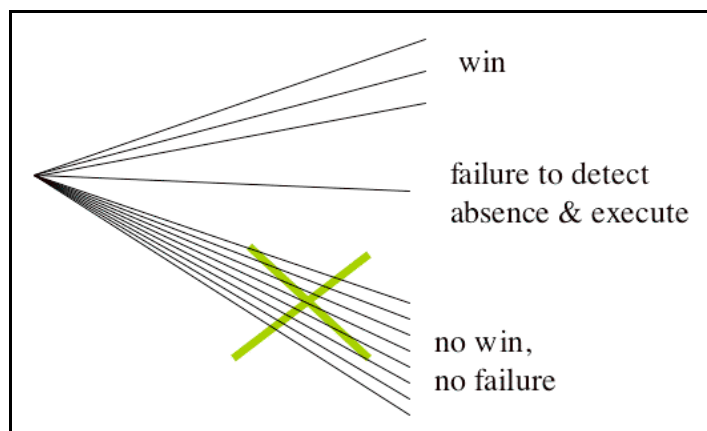
Unfortunately, while my accomplice might be perfectly able to recognize a tiny magical green elf if such a being were to appear, this does *not* at all imply that he can detect that one has *not* appeared. Just because my friend believes there is a magical elf in the room, does not mean that there *is* one, and that it will continue to be there, acting lawfully and stably like a magic green elf in the future when I wake up (whatever the laws governing magical green elves are!).

For instance, my friend might be hallucinating an elf, in which case, when I wake up I will see nothing unusual at all (other than an apparently schizophrenic friend). Or, perhaps a second friend heard about the vile experiment, and is trying to save my life by faking the appearance of a magic elf, complete with dry ice, magic tricks and special effects. Both of these possibilities, and probably many more, are almost certainly *far* more probable than a real, probabilistically stable, tiny magical green elf appearing in a puff of smoke.



**Figure 3. Intractability of Major Miracles (Invocation Miracle).**

This problem was not so insurmountable with the lottery miracle, since in that case it was arguably possible (although undoubtedly extremely difficult) to detect a winning lottery number accurately enough that the probability of incorrect detection was sufficiently lower than the probability of having a winning number.



**Figure 4. Tractability of Minor Miracles (Lottery Miracle).**

I would strongly suspect, however, that a one in ten million lottery draw might be too difficult to pull off in practice. Even if it is doable, one might well have to spend the equivalent of the prize money just setting it up. Even if one is absolutely sure that the winning number is being chosen in a way that is truly random on the quantum level, it is difficult to imagine a suicide method that



one could be confident would work every single time out of ten million cases. Automated methods would suffer from some degree of mechanical failure, and accomplices are fallible and liable to chickening out. So even a small-time lottery win, on the order of one in a thousand, would still be very difficult to set up—let alone one in ten million! The point remains, however, that the minor lottery miracle is doable on *some* level, however impractical it might turn out to be for really large jackpots.

## 5.2 *Reliability of Suicide Method*

Essentially the same problem we had with the detection method reappears in the suicide method itself. For instance, if a gun is used, what is the probability of its jamming and not firing? Or inflicting serious injury, rather than death? In the case of a human accomplice, what is the chance that they will chicken out, or faint? Even something as unlikely as the bullet's vaporizing before it hits you is still probably much more likely than the magical elf you are trying to create. You would be much better off trying to breed a kennel of dogs to evolve into magic elves!

## 6 **Failure Conditions**

We can lump the detection and suicide reliability problems together, into the more general problem of reliably detecting the *absence* of the ideal we seek, and then successfully performing the suicide. Assume that  $p(\text{ideal})$  is the probability of the ideal actually happening, and  $p(\sim\text{ideal})$  is the probability of the ideal not happening. In the absence of the ideal, the probability of successfully detecting the absence and committing suicide is  $p(\text{suicide})$  and the probability of failing to do so is  $p(\sim\text{suicide})$ .

$$p(\text{suicide}) + p(\sim\text{suicide}) = 100\%$$

$$p(\text{ideal}) + p(\sim\text{ideal}) = 100\%$$

From this, we can state the condition for failure of miracle generation (where '>>' here means 'sufficiently greater than'):

$$p(\sim\text{ideal}) \gg p(\text{suicide})$$

$$p(\sim\text{suicide}) \gg p(\text{ideal})$$

These two forms are logically equivalent. The condition states that the miracle will fail if the probability of failing to detect the absence of the ideal and commit suicide is sufficiently greater than the probability of the ideal happening.

The lottery miracle certainly seems doable by these standards, although with odds like 1/10,000,000, it would be tricky business indeed. The magic green elf, on the other hand, is certainly unachievable. Even if we drop the requirement for him to be consistently magical, his appearance is sufficiently improbable to be considered effectively impossible.

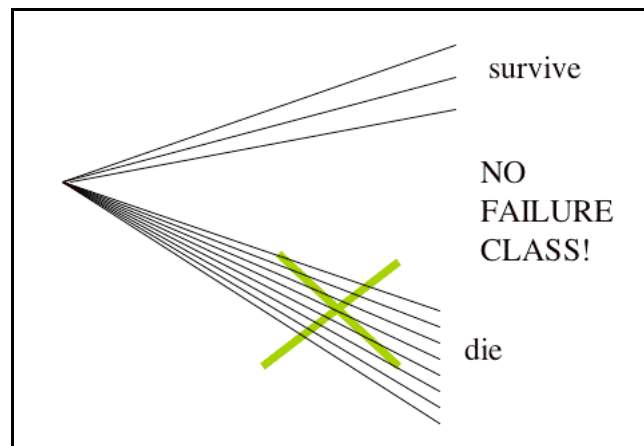
## 7 Immortality

### 7.1 *Least Miracle Required for Salvation*

So minor miracles are possible, assuming the Many Worlds Interpretation—but at a cost few would be willing to pay. And more dramatic miracles, which actually seem to accomplish the impossible, are probably just that: impossible. But what about the miracle some would consider the most desirable of all: immortality? One might think this is surely a major miracle. But this is not so obvious. Immortality is a very special kind of miracle, with surprising properties. What

happens if I try the lottery trick here? That would mean that I kill myself in all worlds where I do not survive. But this is already done for me, by definition! No consideration need be given here to methods of suicide and their probabilities of failure, since mere survival is all we care about. As long as I *do* survive in even a tiny, tiny percentage of worlds, then immortality is automatically mine. This means that I am *already* immortal, no further argument required. Let's celebrate!

Or so goes the argument.



**Figure 5. Universal Immortality: A Tractable Major Miracle?**

What I have outlined above is the basic structure of the immortality proofs I mentioned earlier, put forth by people like Perry and Tipler.[15][18][25] I will call them 'Computational Unity Proofs', since they critically depend on Strong AI, and on the Synthetic Unity of Consciousness (or something very much like it).

I will distinguish between four increasing degrees of immortality:

*Practical immortality*: freedom from biological aging and disease

*Physical immortality*: having a lifespan limited at most by the aging of the universe itself

*Complete immortality*: having a lifespan limited only by logic

*Literal immortality (eternal life)*: having a literally infinite lifespan

Time and lifespan here are measured subjectively—from the viewpoint of the individual in question. People who are practically immortal are only 'immortal' until a fatal accident catches up with them. Those who are physically immortal are, roughly speaking, 'immortal' to the end of time. Those who are completely immortal are as 'immortal' as it is logically possible to be. And those who are literally immortal will simply *never* die, period. For our current purposes, I will take immortality to mean physical immortality, as defined above (give or take).

Applying a probabilistic analysis to the Computational Unity Proofs yields a 'least miracle required for salvation' rule: if a miracle is required to save us from death, then the most probable such universe is the one with the least miraculous method of salvation. Unlike arguments for other kinds of major miracles, Computational Unity Proofs are not so easy to dismiss. On the other hand, I do not think they are so clear-cut as some of their advocates seem to believe, as we will soon see.

## **7.2 Accidental Death**

If I get run down by a passing bus, there will clearly be *some* universes in which I survive—at least from the point of view of some time shortly before the accident occurs. At the point when major miracles would be required to save me (such as the bus levitating in the air, just missing me), it is possible that my death becomes 100% fated to happen—that is, if major miracles are

eliminated as a possibility. But even if they *are* eliminated (and we will show in the next section that they essentially are), my doomed state will not last for very long. Given the generally chaotic nature of the world, it seems a safe bet that this doomed state will not be reached until shortly before the accident (just as in the lottery draw). Thus, so long as I can live with the fact that I might, in a small percentage of universes, exist for brief periods of time with the knowledge that I will die, then minor miracles offer a kind of immunity from death by accident.

To some extent, this is a matter of attitude. I can, if I choose, view these brief fated periods (which are bound to exist in some worlds) the same way I view short periods of memory loss within a single universe. Many of us have experienced short-term memory loss, such as from an accident or drinking binge. We do not generally consider the loss of a few hours to be a form of death. Likewise, why should we fret over the fact that we will be briefly fated to die, in some small percentage of future worlds? Of course, this is no excuse for recklessness, since getting hit by a bus could still leave you in pain and suffering for a prolonged period of time.

As with the lottery, this is not an effect that is publicly verifiable. Minor quantum miracles *subjectively* protect *you* from such accidents, increasing your life expectancy indefinitely. But only you are permitted to eliminate worlds in which you accidentally die from your future wavefunction. From everybody else's viewpoint, you will succumb to some accident or other at some point, just like everybody else. Of course, to each of *them*, they may consider their own life expectancy to be indefinite. The effect is not, in other words, publicly verifiable.

But unlike the lottery example, this effect is not even, in general, subjectively verifiable for particular cases, since these occur accidentally, rather than being intentionally set up as in the lottery example. So even *you* will not know when such minor miracles have happened to you.

### 7.3 *Aging*

Of course, for those who seek immortality, what really matters is whether we can conquer aging, since that is the cause of the inevitable death that seems to await us all. But for that, we may have to invoke major miracles. Imagine I am 98 years old and on my deathbed, and medicine is not yet advanced enough to keep me alive any longer. It seems on the face of it unlikely that continued survival, in spite of my advanced age, would be *logically* impossible. Surely, we might argue, in some tiny percentage of worlds, events will conspire to keep me alive at least a little bit longer in my advanced age—even if major miracles are required. Unfortunately, if this is what is in store for me, I had best be very afraid, as it will lead to a state of eternally increasing decrepitude, in which I spend the rest of eternity (or at least until the universe winds down) undergoing a series of ever-more-miraculous 'least miracles required for salvation', just barely keeping me alive. This sounds less like my ideal of immortality, and more like some Struldbrugian Hell. Okay, this is *not* what I had in mind. Help!

Tipler and Perry avoid this problem by suggesting that the most likely way for me to survive is *not* the least miracle required to keep me decrepit, but rather a miracle that essentially causes me to 'quantum jump', like an electron, to a spatially and temporally disconnected high-tech resurrection, either in the far future or a completely different universe! This occurs because, in some universe, high-tech future beings (or perhaps aliens) will build a robotic replica sufficiently like me that the Computational Unity of Consciousness forces us to conclude that it *is* me. How do the high-tech beings achieve this feat, in spite of the fact that I have been long dead (or in the case of the alien universe, never lived at all)? Perry suggests that they simply build the best replica they can, and fill in the rest with a lucky guess. Tipler suggest some (slightly) more

plausible scenarios, but admits they might not work, and so ends up resorting to our being accidentally recreated by sheer enumeration, given the Many Worlds Interpretation. Resurrection by brute force guesswork!

Is this more likely than eternal decrepitude? I cannot say. It seems to me that the calculation required to answer this question is simply beyond us. However, we do have the tools of algorithmic probability at hand. A program that simulates *just* my brain *without* including any information about the rest of the universe, I will call 'B'. A program that simulates the entire universe, including my brain, I will call 'U'. The Computational Unity of Consciousness demands that the number of bits required to encode B is much larger than the number required to encode U:

$$I(U) \ll I(B)$$

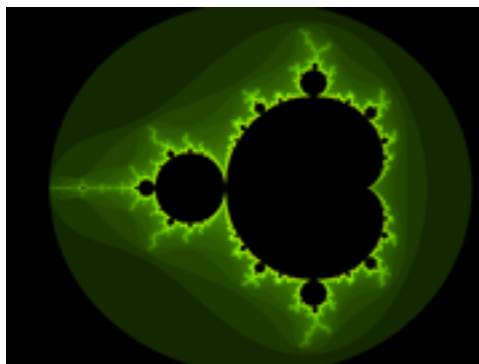
$$p(U) \gg p(B)$$

This sounds completely counter-intuitive—why would the program for the whole universe (including my brain) be shorter than that for my brain alone? But, given a computational metaphysics, it must be the case. If it were not, and my brain on its own had the shorter program, then my brain on its own would be the more probable state to find myself in. Yet, we know from experience that the most probable state to find ourselves in is one of a large, complex and law-like environment, so if our computational metaphysics is correct, it must take more bits to describe a brain alone than an entire universe.

And on reflection, it is not so counter-intuitive after all. The Mandelbrot Set is a large, infinitely varying fractal pattern that appears very complex if a piece of it is viewed on its own. Yet, the entire set is generated by a tiny program. The entire observable universe appears to be evolving

out of a Big-Bang that started as an infinitely small point, or singularity—or at least something much smaller and simpler than the present universe appears to be. Thus, it is actually quite feasible that the ultimate program size of our universe is, like that of the Mandelbrot set, far smaller than what would be required to describe local structures within it—in the case of our universe, its program size is less than a brute force description of a human brain in isolation.

$$\begin{aligned} \{c\} : \lim_{n \rightarrow \infty} z_n < \infty \\ z_0 &= 0 \\ z_{k+1} &= z_k^2 + c \end{aligned}$$



**Figure 6. Mandelbrot Set: Global Simplicity, Local Complexity**

Let's now return to the 98-year-old version of me on his deathbed. Presume that a typical universe in which I die has a very short program (i.e. is highly probable). A contrived universe in which I am miraculously saved, on the other hand, has a very long program, perhaps not even having the same history as the real universe (it might even be a simulation in a computer inside an even larger universe).

So all we have to do to refute *both* the eternal decrepitude *and* the brute force resurrection theories is to show that there exists some other kind of universe that also continues my consciousness, but whose shortest program size is on the same order of magnitude as the information content of *just* my brain, B. Such a universe would be much more probable (have a shorter program) than the highly contrived miraculous universes mentioned above, and hence



would be much more probable (but not nearly as probable as the 'real' universe, U, so it would still be a miraculous world).

We can do this by constructing a program that simulates my brain *without providing a spacetime environment for it*. We replace the spacetime environment with a virtual reality (VR) of negligible program size, which feeds the brain essentially random input. This is a lot like dreaming: the brain stem floods the brain with random noise, and the brain free-associates a dreamworld in response.[4] But a dreamworld has little stability and is not very law-like in its behavior. Also, there would be little reason for this replica brain to be competent at storing long-term memories, since these would likely not be necessary to simply continue my stream of consciousness. Such a brain might also have many other unfortunate defects (remember, this is the *least* required miracle, and there is no alien or high-tech intelligence in this random-VR world to make sure that my brain is constructed in a reasonable fashion).

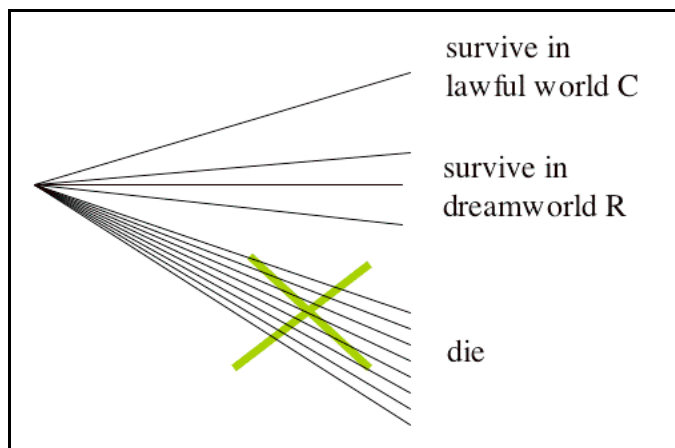
Let us call the random-VR universe 'R', for 'random'. The guesswork universe and/or the eternal decrepitude universe we will call 'C', for 'contrived'. R is much less probable than U, essentially equal in probability to B, and much *more* probable than C:

$$I(U) \ll I(B) \approx I(R) \ll I(C)$$

$$p(U) \gg p(B) \approx p(R) \gg p(C)$$

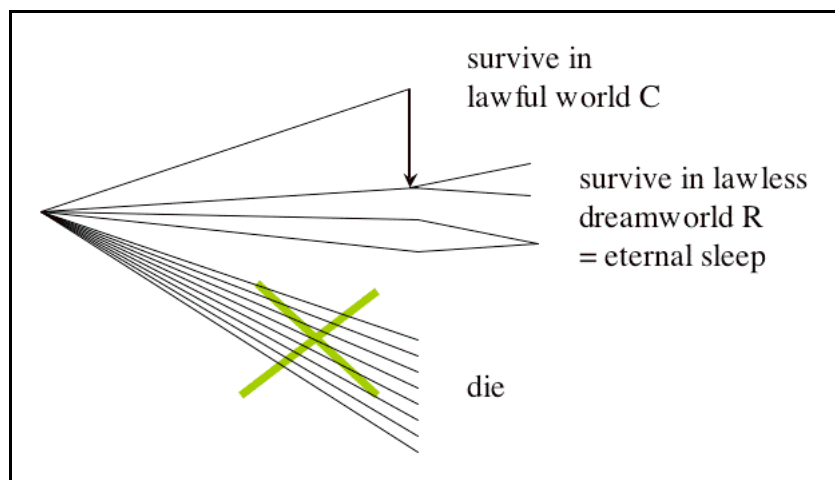
So yes, the Many Worlds Interpretation guarantees that a future resurrection world exists, tailored just for me, out there somewhere in the universal wavefunction—such a world is a *logical* possibility. But this does not actually make me immortal, since I am *much more* likely to quantum jump into a dream-like state than into such a futuristic paradise. Such a paradise, unlike

the real universe, lacks stability (and thus we might be justified in refusing to even call it 'physical', a 'world' or a 'universe').



**Figure 7. The Intractability of Universal Immortality.**

Even if I fantasize about being that lucky, logically possible chap who *does* quantum jump into a futuristic robotic replica, this still places that version of me in a universe with vastly *lower* probability than the random VR, practically guaranteeing an immediate quantum jump back into the random VR again. And in the random VR, not only does the environment lack lawful behavior, but it is doubtful that one's brain would even function properly or lay down memories in any kind of reliable fashion... remember that this is the least miracle required for continued consciousness. There would be little distinction, in fact, between various random so-called 'worlds'. They would all tend to blend into each other, and it would be difficult to define any coherent long-term history for any of them as distinct from the others. I think it is not too presumptuous to suggest that living in such a random, incoherent world of transience would be less like living and more like a state of eternal sleep. In other words, the future me who lies on his deathbed, with no immortality medicine to save him, is as good as dead.



**Figure 8. The Instability of Universal Immortality.**

#### 7.4 Cryonics

So quantum major miracles have turned out to be illusory as a means to immortality. This is not so surprising, since they require violations of classical thermodynamics on a massive scale (although I have nowhere *assumed* the validity of classical thermodynamics in refuting them). Are we destined to die then? Not necessarily. Exciting new advances in anti-aging and related biotechnologies have been and are being developed, including dietary supplements, genetic manipulation, therapeutic cloning, embryonic stem cell research and nanotechnology. There is a real possibility some sort of immortality will be achieved in the near-future.

But will we live to see it? Remarkably, a good argument can be made that the required technology already exists. Cryobiologists have had the capability, since around the turn of the millennium, to cool a human patient's brain to a temperature below around  $-125^{\circ}\text{C}$ , so as to 'vitrify' it.[13] This means that the brain does not 'freeze' in the conventional sense, which would create massive cellular damage from ice crystal formation, and place nonmiraculous revival possibly out of reach. When a brain is vitrified, the tissue forms a crystal-free 'glass'. So if you

make cryopreservation arrangements before you die, all your 'soul-critical' neurological information will be saved for future retrieval when the technology is available.

Some may argue that the technology for reviving cryopreserved patients will *never* come about, but given the pace of technological achievements over the past 500 years, I find this position hard to credit. Even if the preserved brain is not organically viable, it should still be possible to read off the neurological information and transfer the person's informational soul into a robotic replica. Unless we reject Strong AI, there is no reason to suppose we could not one day accomplish this, especially if we allow for the development of nanotechnology, and the manipulation of matter at the atomic scale.

Perhaps you are concerned that a brain vitrified in the 21st century will surely meet some unlucky demise before the resuscitation technology is available. The cryonics company might go out of business and you will thaw out. There could be a nuclear holocaust. Or an earthquake. Or cryonics might be legislated against, and shut down. Or any number of other obstacles might arise to prevent your revival.

Fortunately, this is another area where minor miracles come to the rescue. From your personal perspective, the wavefunction of the entire rest of the burgeoning universe *goes into superposition while you are vitrified*. This must be the case, since you cannot make an observation—in fact your consciousness does not change at all—while cryopreserved. That means, so long as there is *some* historical time-line where the requisite technology is developed, and where people decide to bring you back, then you *will* come back... so long as the history in question is stable (no major miracles allowed). As with the lottery, the effect is verifiable only to you (but that doesn't mean it won't work!).

Minor miracles could be used in other ways to improve your subjective chances of survival. As of this writing, vitrifying a human brain requires very expensive refrigeration equipment, if significant fracturing is to be avoided. Therefore, cryonics patients are stored in inexpensive liquid nitrogen instead, which is too cold, and fracturing cannot be avoided. Now assume that your cryonics company has the capability of preserving just a *single* patient with the better (but more expensive) technology. Upon your legal death, the company rolls the quantum dice, giving you a small but nonmiraculous chance of being preserved with the better technology.

Even assuming that the better technology is absolutely required for your revival, you are subjectively guaranteed to be revived, since you will be preserved with the better technology in a nonmiraculous percentage of worlds. To reduce their chances of having to cryopreserve more than a single patient with the better technology (or else refuse the lottery to future patients), the cryonics company can set the probability of winning the cryonics lottery quite low if they wish, so long as it is not so low as to put the whole exercise into the 'major miracle' category.

As it turns out, cost-effective, fracture-free cryopreservation is probably just around the corner, but this is just one illustration of the principle; it can be used wherever an improved, but prohibitively expensive, method of preservation becomes available.

The Computational Unity assumptions (the Synthetic Unity of Consciousness and Strong AI), which are perhaps our most controversial assumptions, are not required for the minor cryonics miracles. There is no quantum jumping into new bodies or worlds here, and no major miracles. So long as one allows that quantum mechanics is true of the Universe as a whole (mandating Many Worlds) and that revival from cryopreservation, without major miracles, is at least possible by *some* level of technology (however advanced), then the argument holds.

## 8 Conclusion

We have seen that minor quantum miracles are possible. But these are 'miracles' of a very special and restricted kind, since they do not violate our usual notions of what is physically possible, and they are unverifiable to others. Major miracles would be verifiable to everyone, but we have seen that there is reason to consider them effectively impossible. I therefore propose that we label both micro miracles *and* unverifiable minor miracles with the term 'quasi-miracle', so that only major miracles or publicly verifiable minor miracles would be considered *true* miracles (these being just the ones that are intractable). This distinguishes between fantastic-sounding claims about quantum effects that are nonetheless valid (quasi-miracles) and flights of fancy that are physically, but not logically, impossible (true miracles).

As for immortality, there seems insufficient reason to make bold claims about the inherent immortality of the soul based on quantum physics (although I would not rule out the possibility that a convincing quantum proof for universal immortality might yet be forthcoming). The conservative stance would be to *not* expect major miraculous events to save one from death, but rather to expect that some humans have actually died and will die, and will not come back... in any universe. All will not be saved. However, we should be able to reach a point in the relatively near future when technology can nearly eradicate death. And quantum mechanics does give us reason to have less fear of accidental death, including accidental loss of the soul-critical information in our vitrified brains if we are cryopreserved. So it is likely that those vitrified now, or at least in the very near future, will be—from their own point of view at least—essentially immortal.

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