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Modern Astronomy and Cosmology: Room for a Creator?

An explanation of our current understanding of the universe, how it began, and a reflection on the religious implications.

by

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'The more the Universe seems comprehensible, the more it also seems pointless'.

The words of Nobel Laureate, Steven Weinberg in his book *The First Three Minutes.* He goes on to dismiss human life as '*a more-or-less farcical outcome of a chain of accidents*'. Stephen Hawking in his best-selling popularisation of cosmology, *A Brief History of Time,* concludes with the question *What place then for a creator?*

The study of modern astronomy and cosmology is such that it is virtually impossible *not* to go beyond the science itself, and reflect on the possible significance of such findings for our understanding of ultimate questions - those to do with religion, purpose, and human significance in general.

What I want us to do this evening is to examine some of the issues raised to see whether the scientific study of the universe is as damaging to religious belief and to our own sense of worth as is sometimes portrayed?

So let me begin with a brief resume of what the universe is like and how it originated:

The Sun is a ball of fire. It is large enough to swallow up one million earths. It is but a medium-sized star, much like the others. Stars are gathered into great swirling whirlpools called galaxies. Ours is called the Milky Way Galaxy. It contains 100 000 million stars. There are other galaxies besides our own - some 100 000 million of them spread out over vast tracts of space
So how many stars are there altogether? Suppose we were to take a tiny grain of sand to represent each of these stars - each of these suns - how much sand would we need? A bucket full? A barrow load? A truck load? No. We would need enough to make a sand castle 5 miles long by 5 miles wide by 5 miles high.

The galaxies are spread out over vast tracts of space. The furthest lie so far from us that the light we receive from them today has taken 12 000 million years to reach us - even though it has been travelling at a speed of 300 000 kilometres per second. The galaxies are grouped together into clusters of galaxies, our own being a member of a cluster of about 30 galaxies.

When we look at distant galaxy clusters we find that they are all receding from us. The further away they are, the faster they are retreating off into the distance. This motion arises out of the way the universe began. According to the Big Bang hypothesis, we envisage that there was a time when all the contents of the Universe were together. They flew apart, and have been doing so ever since. From the motion of the galaxies and the distances they have travelled at those speeds, we can conclude that it happened 12 000 million years ago. It was such a cataclysmic event it seems natural to assume that it marked the point at which the Universe came into being. That being so it seems reasonable to ask what *caused* the Big Bang. And that is the first big question we are to address this evening.

The religious response is to say that God created the world. But there are those who do not see God as necessary for this purpose. They argue that the world might have created itself - spontaneously - one simply puts it down to a quantum fluctuation. So, what is meant by that?

In the days of classical Newtonian physics, one thought that everything that happens has to have a cause. Cause is followed by effect. Everything is predictable - at least in principle. If one repeatedly sets up the identical causal event, one always gets exactly the same effect.

With the advent of quantum theory all that changed. Now we know that from a given state of affairs, one can predict only the relative *probabilities* of a whole variety of possible later states. For instance, a 60% chance of one thing happening, a 30% chance of another, and a 10% chance of another. There is absolutely no way of determining in advance which way it will go; one just has to wait and see. As I said, all one can deal in are relative probabilities of various possible outcomes.

This element of uncertainty - unpredictability - affects everything happening in the world. The fact that it is not obvious in everyday life is because the effects only become noticeable on the small scale. This generally means one has to be examining the behaviour of individual atoms or of subatomic particles like electrons and protons.

But the uncertainty is always there. In particular, one would expect quantum theory to be important in the very earliest stages of the universe, when the universe was very small.

This being so, some physicists have been led to propose that, starting from a state consisting of nothing, there might have been a small but finite probability that this would be succeeded by a state consisting of a Universe - a tiny universe of sub-atomic proportions - a universe that promptly underwent a Big Bang and became the enormous universe we know today. One has simply to wait around long enough for this quantum fluctuation to occur.

This then is a possible way, so it seems, for having the Universe spontaneously create itself, without the active involvement of any Creator God.

The proposal, at first sight at least, appears quite plausible, but it is not without its difficulties. Quantum theory was devised to account for the behaviour of the component parts of the Universe; it does not by any means follow that one is justified in applying it to the Universe as a whole. Indeed, quantum theory is the description of the observations of an observer. But who is supposed to be the 'observer' in this case - an observer who in some sense is *outside* the universe? It sounds suspiciously like God again. A further difficulty is that if there is a finite probability of this Universe popping into existence at some point in time, why not other universes at other points in time? Is one not led to the conclusion of there being universes without number? That seems a rather extravagant claim - a costly way of getting rid of a Creator God.

But setting aside for the moment these various objections, suppose for the sake of argument we were to concede that the world had its beginning in a quantum fluctuation, would that in fact undermine the idea of a Creator God?

I think not. It is all very well putting the Big Bang down to a quantum fluctuation, but why a *quantum fluctuation*? Why was it quantum physics that was in charge of the process rather than some other type of physics? After all, we can all dream up imaginary worlds run according to laws of nature different from our own. Science fiction writers do it all the time. Where is quantum physics supposed to have come from? Would it not have taken a God to have set up the laws of physics in the first place - a God who *chose* the laws for bringing this world (and perhaps others) into existence. This would have put God at one step removed from the origin of the Universe in that, instead of initiating the world by direct intervention, he created the law, it then being the natural outworking of that law that brought the world into existence. And yet responsibility for the existence of the world would ultimately have rested with the creator of the law - with God.

I wish now to turn to what I regard as the most intriguing aspect of the Big Bang. So far we have been speculating on what might have caused the Big Bang - a quantum fluctuation or God. But what I want to talk about now throws doubt on whether there was a cause at all.

In describing the Big Bang I have probably given you the idea that it was an explosion much like any other explosion - bigger, yes, but essentially the same. By that I mean that it takes place at a particular location in space. But this is not how it was with the Big Bang. Not only was all of matter concentrated initially at a point, but also all of space. There was no surrounding space outside the Big Bang.

Perhaps an analogy will help. Imagine a rubber balloon. Onto its surface we glue some 5p coins. The coins represent the galaxies. Now we blow air into the balloon. It expands. Suppose you were a fly that has alighted on one of the coins; what do you see? You see all the other coins moving away from you - the further the coin, the faster it is receding into the distance. A coin twice as far away as another is receding twice as fast. But that of course is the observed behaviour of the galaxies - they too are receding from us in exactly that manner.

So far we have thought of the galaxies as speeding away from us as they move through space. But with the balloon analogy in mind, we now have an alternative way of interpreting that motion. It is not so much a case of the galaxy moving *through* space, as the space between us and it *expanding*. The galaxy is being carried away from us on a tide of expanding space. Just as there is no empty stretch of rubber surface 'outside' the region where the coins are to be found (a region into which the coins progressively spread out), so there is no empty 3-dimensional space outside where we and the other galaxies are to be found.

It is this interpretation of the recession of the galaxies that leads us to conclude that at the instant of the Big Bang, all the space we observe today was squashed down to an infinitesimal point. Because of this, it becomes natural to suppose that the Big Bang not only marked the origins of the contents of the Universe, it also saw *the coming into existence of space*. Space began as nothing, and has continued to grow ever since.

That in itself is a remarkable thought. But an even more extraordinary conclusion is in store for us - once we acquaint ourselves with Einstein's theory of relativity. What it tells us is that space and time are more alike than one would guess from the very different ways we perceive and measure them. After all, we measure spatial distances with rulers and intervals of time with a watch or clock. Yet despite this, there is an exceedingly close link between the two, to the extent that we speak today of time as the 4th dimension. We are all familiar with the three spatial dimensions. Time is now to be added as the fourth. For our purposes, it is sufficient to accept that

space and time are as indissolubly welded together as the three spatial dimensions are to themselves. One cannot have space without time, nor time without space.

The reason why I am telling you this now is because of what I said a little earlier about space itself coming into existence at the instant of the Big Bang. In the light of what I have now asserted about the indissoluble link between space and time, we can immediately proceed to the conclusion that the instant of the Big Bang must also have marked the *coming into existence of time.* This in turn means that there was no time before the Big Bang. Indeed, the very phrase '*before* the Big Bang' has no meaning. The word 'before' necessarily implies a pre-existent time - but where the Big Bang was concerned, there was none.

Now, for those who seek a *cause* of the Big Bang - whether a Creator God or some impersonal agency - there is a problem here. We have already spoken of the causal chain: cause followed by effect. Note the word 'followed': it refers to a sequence of events in time: first the cause, then the effect. But in the present context we are regarding the Big Bang as the effect. For there to have been a cause of the Big Bang, it would have had to have existed prior to the Big Bang. But this we now think of as an impossibility.

It was this lack of time before the Big Bang that prompted Hawking in his book *A Brief History of Time* to remark 'What place then for a creator?' Without there being any time, it certainly gets rid of the kind of creator God that most people probably have in mind: a God who at first exists alone. Then at some point in time God decides to create a world. The blue touch paper is lit, there is a Big Bang, and we are on our way. God becomes the cause of the Big Bang. But as we have seen, without time before the Big Bang, there could not have been a cause in the usual sense of that word.

It has to be said that exactly the same problem confronts the alternative idea we have been discussing whereby the cause of the Big Bang is thought to have been a quantum fluctuation. According to that scheme, an initial state consisting of nothing was (thanks to the quantum fluctuation) 'followed' by a world that promptly underwent the Big Bang. In the absence of any prior time, there could no more have been that kind of 'initial' state (one that could undergo a quantum fluctuation), than there could have been a God. Indeed, the only kind of quantum fluctuations we know of are those that occur in space as well as in time. Prior to the Big Bang, there was neither.

So, where have we got to? Have these considerations dispensed with a creator God? Before jumping to that conclusion, let us consider the following quotation:

'It is idle to look for time before creation, as if time can be found before time. If there were no motion of either a spiritual or corporeal creature by which the future, moving through the present, would succeed the past, there would be no time at all... We should therefore say that time began with creation, rather than that creation began with time.'

If the archaic expression 'either a spiritual or corporeal creature' had been replaced by a more up to date one - such as 'a physical object' - one could well have thought that the quote came from some modern cosmologist like Hawking, or from Einstein. In fact, those are the words of St Augustine. I think you will agree, they beautifully sum up what I have been trying to say. Modern cosmologists find it hard to come to terms with the fact that, where the beginning of time is concerned, it was a theologian who got there before them - and by 1500 years.

How did he do it - bearing in mind that St Augustine obviously knew nothing about the Big Bang? He argued somewhat along the following lines:

How do we know that there is such a thing as time? It's because things change. Physical objects (for instance, the hands of a clock) occupy certain positions at one point in time, and move to other positions at another. If nothing moves (or in the past had *ever* moved), there would be nothing to distinguish one point in time from another. There would be no way of working out what the word 'time' was supposed to refer to; it would be a meaningless concept. *A fortiori*, if there were no objects at all, moving or stationary (because they had not been created), clearly there could be no such thing as time.

In this way, Augustine cleverly deduced that time was as much a property of the created world as anything else. And being a feature of that world, it needed to be created along with everything else. Thus it makes no sense to think of a time that existed before time began. In particular it makes no sense to think of a God capable of pre-dating the world.

Yet despite all this, Augustine remained one of the greatest Christian teachers of all time. His realisation of the lack of time before creation clearly had no adverse effect on his religious beliefs. To understand why this should be so, we have to draw a distinction between the words 'origins' and 'creation'. Whereas in normal everyday conversation we might use them interchangeably, in theology they acquire their own distinctive meanings. So for example, if one has in mind a question along the lines of 'How did the world get started?' that is a question of origins. As such, it is a matter for scientists to decide, their current ideas pointing to the Big Bang description.

The creation question, on the other hand, is quite different. It is not particularly concerned with what happened at the beginning. Rather it is to do with: 'Why is there something rather than nothing?' It is as much concerned with the present instant of time as any other. 'Why are *we* here? To whom or to what do we owe our existence? What is keeping us in existence?' It is an entirely different matter, one not concerned with the mechanics of the origin of the cosmos, but with the underlying ground of all being.

It is for this reason one finds that whenever theologians talk about God the Creator, they usually couple it with the idea of God the Sustainer. His creativity is not especially invested in that first instant of time; it is to be found distributed throughout all time. We exist not because of some instantaneous action of God that happened long ago - an action that set in train all the events that have happened subsequently - an inexorable sequence requiring no further attention by God. We do not deal with a God who lights the blue touch - and *retires*. He is involved at first hand in *everything* that goes on.

So much for reflections deriving from Hawking's writings.

How about Weinberg's assessment of the Universe as being pointless and of human life as being but a farcical outcome of a chain of accidents? Is the nature of the Universe, as revealed by modern astronomy and cosmology, such that one can only conclude that life is a chance by-product?

It is not difficult to appreciate how Weinberg arrives at such a gloomy assessment. Take for example the size of the Universe. Are we really expected to believe that God designed it as a home for humans? If so, it appears to be somewhat excessive - a case of over-design perhaps.

Most places in the Universe are hostile to life. The depths of space are incredibly cold; that is why most planets are freezing. To be warm a planet needs to be close to a star. But get too close - like Mercury and Venus - and they become too hot. And of course the most prominent objects in the sky, the Sun and the other stars, are in themselves balls of fire and hence not suitable places to find life. Planets tend to be without atmospheres, or if they do have one, it is likely not to be the right sort for sustaining life.

For the great majority of the history of the Universe there was no intelligent life. After a further 5000 million years our Sun will swell up to become a red giant. Though it is unlikely that its fiery surface will reach out far enough to engulf the Earth, our planet will become unbearably hot, and all life will be burned up. This assumes that life has not already been eliminated through the violent impact of a meteorite, like the one that hit Jupiter recently.

And what of the long-term future of the Universe as a whole and of life elsewhere? We have spoken much about the origins of the Universe in the Big Bang, but what of its end?

We have seen how the Universe is expanding. The distant galaxies of stars are still receding in the aftermath of the Big Bang. But as they rush off into the distance, they are slowing down. This is due to gravity, each galaxy exerting an attraction on every other one. Keep this up, and eventually the galaxies will be brought to a halt. Except that we have to remember that the force of gravity reduces with increasing distance. So the slowing down force is steadily reducing with time.

The big question is then whether it will have managed to stop the galaxies before its force essentially vanishes to nothing, or whether the speeds of the galaxies are so great they will succeed in escaping the pull of gravity.

If it is the first, then the galaxies will one day come to a halt, and from then on will be drawn back towards each other. All their separations will reduce until eventually everything comes piling back on top of each other in a Big Crunch - with obviously the extinction of all life. So that is one possible scenario.

The alternative is that gravity is too weak to stop the galaxies, and they will continue flying apart for ever. What would be the significance of that for life in the cosmos?

Each star has only a limited amount of fuel. Eventually its fires must go out. For a medium sized star like the Sun that takes a time of the order of 10 000 million years (the Sun is about half way through its active life). More massive stars have more fuel, but they achieve higher temperatures and burn their fuel faster - so much faster they might live for only 1 million years. As each star exhausts its fuel, it becomes cold and no longer able to keep companion planets warm enough to sustain life.

Mind you, new stars continue to form. A star is created when the hydrogen and helium gas that was emitted originally from the Big Bang collects together under the influence of its mutual gravity. It squashes down, heating up as it does so (in the same way as air squashed down in a bicycle pump gets hot). If enough gas is collected, the temperature rise becomes sufficient at the centre to ignite nuclear fusion. In a very hot gas, the atomic nuclei are moving about so fast they can fuse together to form heavier nuclei. These heavier nuclei are so efficiently packed together that they are able to release unwanted energy - the energy of nuclear fusion. (The modest heat of the squashed-down gas acts only as a trigger to get the much more energetic nuclear fusion reactions going,

in the same way as the lighting of a domestic coal fire involves first setting light to some screwed up paper - the small output of heat from this being the trigger to get the coal burning.)

Not all the gas from the Big Bang was used up in producing the first generation of stars. Our own Sun was one of those formed at a later stage. Still more stars are to be seen today in the very earliest phases of getting underway. But it is clear that this is not something that can go on indefinitely. At some stage, *all* the hydrogen and helium gas will have been drawn together to form stars, or will have been dispersed so thinly as never to be incorporated into a star. From then on the last stars live out there active lives, and die. Everything cools down, and we are left with the Heat Death of the Universe.

So what we find is that if we are dealing with a Universe where the expansion goes on for ever, there will come a point when there can be no further life. One is then left with an ever dispersing, lifeless Universe for an infinity of time. So Big Crunch, or Heat Death, the future is bleak for life either way. Yes, as I said, it is easy to see how Weinberg was led to the conclusion that the Universe seems pointless, and life is but an accidental by-product of no significance.

Or is it?

In the first place we need to guard against being irrationally overwhelmed by the sheer size of astronomical objects. Certainly there are contexts where size is significant. From a purely physical standpoint, the Sun is clearly more important than we are. After all, we go round the Sun; the Sun does not go round us. But would you want to swap places with the sun? Even though you might like to feel important, is that sufficient reason for changing places? The answer obviously is no. What's the point of being important if you don't *know* that you're important - and presumably the Sun does not know that it's important because it does not know *anything* - it's not conscious. The Sun is big, but essentially simple in structure - certainly simple compared to the complexity of the human brain - that complexity being linked in some way to the mystery of our consciousness. No, when it comes to the question of human dignity, we surely ought to be more concerned with consciousness than with questions to do with mere size.

As Blaise Pascal once put it: *It is not in space that I must seek my human dignity, but in the ordering of my thought... Through space the Universe grasps me and swallows me up like a speck; through thought, I grasp it.'*

So much for wise words dating from the 17th century. I wish now to change tack and introduce you to some reflections on the cosmos of a very different nature. These have surfaced only comparatively recently - in the last couple of decades. They go under the general heading: *The Anthropic Principle.*

To see what it is about, I want you to imagine that you are going to make a universe. You have freedom to choose the laws of nature and the conditions under which your imaginary universe is to operate. The aim is to produce a universe that is tailor-made for the development life - the kind of universe God presumably *ought* to have created if it were really intended primarily as a home for life.

The first decision is how violent to make your Big Bang. You might feel for example that the actual Big Bang was somewhat excessive if the aim was simply to produce some life-forms. It turns out that if you make the violence of your Big Bang somewhat less - only a little less - then the mutual gravity operating between the galaxies will get such a secure grip that the galaxies will slow down to a halt, and will thereafter be brought together in that Big Crunch I was telling you about. Moreover, all this happens in a shorter time that 12 000 million years - the time needed for evolution to produce us. So, turn the wick down, and you get no intelligent life.

All right you might say, I'll turn the wick up a little. I'll make my Big Bang just a little *more* violent than the actual one. What happens now, is that the gases come out of the Big Bang so fast that they do not have time to collect together to form embryo stars before they are dispersed into the depths of space. There being no stars, you get no life.

In fact it turns out that as far as the Big Bang violence is concerned, the window of opportunity is exceedingly narrow. If you are to get life in your universe, the thrust must be just right - and that is what our actual Universe has managed to do.

The next point to consider is the force of gravity. How strong will you make it in your imaginary universe? If you make it a little weaker than it actually is you will collect gas together after the Big Bang but not enough to produce a temperature rise sufficient to light the nuclear fires. No stars - no life.

On the other hand, you must be careful not to have your gravity too strong. That way you would get only the very massive types of star. Recall what I said earlier about massive stars burning themselves out in only 1 million years. For evolution to take place you must have a steady source of energy for 5 000 million years - you need a medium sized star like the Sun. Indeed when you come to think of it, the Sun is a remarkable phenomenon. After all, what is a star? It is a nuclear bomb going off SLOWLY. Have you any idea how difficult that is to achieve? Yet the amazing thing is that the Sun manages this. The secret is the way the force of gravity in the Sun conspires to

feed the new fuel into the nuclear furnace at just the right rate for the nuclear fires (governed by the nuclear force - an entirely different force from that of gravity) to consume it at a steady rate extending over a period of 10 000 million years.

So, in order for there to be life, the force of gravity must lie within a very narrow range of possible values - and the gravity of the actual Universe does just that.

Next we must turn our attention to the materials from which we wish to build the bodies of living creatures. This is no small matter. After all, what do we get coming from the Big Bang? The two lightest gases - hydrogen and helium - and precious little besides. And it *has* to be that way. Remember we need a violent Big Bang to stop the Universe from collapsing back in on itself prematurely. And because of that violence, only the lightest nuclei could survive the collisions occurring at that time - anything bigger getting smashed up again soon after its formation. But you can't make interesting objects like human bodies out of just hydrogen and helium. So the extra nuclei - those that go to make up the 92 different elements found on Earth - must be manufactured somehow *after* the Big Bang. That's where the stars have another important role to play. Not only do they provide a steady source of warmth to energise the processes of evolution, they first serve as furnaces for fusing light nuclei into the heavy ones that will later be needed for producing the bodies of the evolving creatures.

But we are not home and dry yet. Perhaps the most important atom in the making of life is that of carbon. In a sense it is an especially 'sticky' kind of atom very good at cementing together the large molecules of biological interest. But forming a nucleus of carbon is by no means easy. Essentially it consists in fusing three helium nuclei together. This is as unlikely as to have three moving snooker balls colliding simultaneously. Without me going into any details as to how this comes about - let me just say that it involves something called a nuclear resonance. The occurrence of this resonance is so highly fortuitous, that its discoverer, one-time atheist Fred Hoyle now declares 'a commonsense interpretation of the facts suggests that a superintellect has monkeyed with the physics'.

So we have our precious carbon. A collision between some of these carbon nuclei and further helium nuclei yields oxygen - another vital ingredient for life - and so on. Thus you must be sure in your imaginary universe to incorporate a fortuitous nuclear resonance.

Does this mean that the stage is now set for evolution to take over, and convert these raw materials into human beings?

Not so. We have our materials, but where are they? They are in the centre of a star at a temperature of about 10 million degrees. Hardly an environment conducive to life. The materials have to be got out. But how? What happens is that a proportion of the newly synthesised material is ejected by supernova explosions. These occur when massive stars - several times the mass of our Sun - run out of fuel. They suddenly collapse in on themselves. But that raises a problem. How can an *im*plosion produce and *ex*plosion? This was a conundrum that exercised the minds of astrophysicists for many years. In the event the mechanism turned out to be the strangest imaginable. The material is blasted out by neutrinos. Neutrinos are famous for hardly ever interacting with anything. One could pass a neutrino though the centre of the Earth to Australia a 100 000 million times before it had a 50:50 chance of hitting anything. They are incredibly slippery. How fortunate they were not any *more* slippery than they are.

The material is now out among the interstellar gases. In time, this collects together to form a dense cloud, which squashes down to form a star. Outside the star there can be secondary eddies that settle down to form planets. It is now possible to have rocky planets like Earth, Mercury, Venus, and Mars. For the first generation of stars this had not been the case because at that stage there had only been hydrogen and helium around. Given a planet at a reasonable position away from the star for a temperate climate to prevail, one has now at last got a chance of life evolving from the primordial slime.

How likely this is to happen is not known. If one is a physicist one tends to be impressed by the vast number of planets there must be out there - in other words how many attempts one is allowed to produce intelligent life. On this assessment, one is indeed home and dry. If on the other hand you are a biologist, you might be more impressed by the size of the hurdles that have still to be negotiated on the way to intelligent life - like for example the formation of the first cell. You might therefore be inclined to think that there must be some more 'coincidences' to follow - biological ones this time rather than the physical ones we have been considering.

The sum total of all these coincidences that have led to the universe being hospitable to life goes under the name: The Anthropic Principle.

It is impossible to put a hard figure on the likelihood of getting life from simply throwing together a bunch of physical laws at random - laws incorporating arbitrary values for the various physical constants. In talking for example about the strength of gravity having to lie within a narrow range, it is impossible to be more quantitative unless there is some way of specifying a permissible range of values that the strength could conceivably take on. If it could be *any value whatsoever*, then the finite range would be divided by infinity - and the chances would be

virtually zero. Whatever the true odds come out to be, it is probably fair to say that to have a universe that is appropriate for the development of life is less likely than winning first prize in the Lottery.

So we are faced with the simple fact that the universe, far from being hostile to life, has seemingly bent over backwards to accommodate life. As the physicist Freeman Dyson has put it, 'The universe knew we were coming.'

Of course, in speaking of life, we are not restricting our thoughts merely to human life here on earth. There could well be intelligent life throughout the cosmos. Indeed, some examples of extraterrestrial life could be more advanced than ourselves. Whether that is likely, and if so, how that would affect our sense of human worth, is in itself another fascinating field of speculation.

The mysterious appropriateness of the Universe for the evolution of life is something that calls for explanation. There appear to be three possibilities:

The first is to pin one's faith on science, and to assert that in the end, science will one day be able to demonstrate that there is no mystery; there is no need to invoke coincidences. Things simply have to be the way they are.

The second way of addressing the Anthropic Principle is to assert that our Universe is not alone. There are a great many universes - perhaps an infinite number of them - and they are all run on different lines with their own laws of nature. The vast majority of them have no life in them because one or other of the conditions were not met. In a few, perhaps in only the one, all the conditions happen by chance to be satisfied and there life was able to get a hold. The probability of a universe being of this type is small but because there are so many attempts, it is no longer surprising that it should have happened. We being a form of life ourselves must, of course, find ourselves in one of these freak universes.

This is a suggestion that has been put forward by some scientists, but that does not make it a scientific explanation. For one thing, the other universes are not part of our Universe and so by definition cannot be contacted. There is therefore no way to prove or disprove their existence. Not only that but the suggestion goes against the conventional way scientific development has tended to go. Scientists generally go for the simplest, most economical explanations. It is what we call the application of Occam's Razor. To postulate the existence of an infinite number of universes all run according to their own laws of nature is to go as far in the opposite direction as is imaginable. Which is not in itself to say that the idea of an infinite number of universes is wrong - merely that it does not count as science.

So, an infinite number of universes is the second way of accounting for the Anthropic Principle. The third alternative is simply to accept that the Universe is a put-up job; it was designed for life, and the designer is God.

Now, one always gets a little bit worried over arguments in favour of the existence of God based on Design. The original Argument from Design held that everything about our bodies, and those of other animals, is so beautifully fitted to fulfil its function that it must have been designed that way - the designer being God - and therefore you must believe in God. The rug was pulled from under that argument by Darwin's theory of evolution by Natural Selection - at least in terms of it being a knock-down proof of God's existence - one aimed at convincing the sceptic.

So it is I would urge caution on those religious believers tempted to make too much of this new Argument from Design - one based this time on physics and cosmology. It is my contention that one can neither prove nor disprove God on the basis of such reasoning. If one is inclined to reject the idea of God, then one can do so in the expectation that science will one day show how the coincidences are not really coincidences, or it can be done on the grounds of there having probably been many attempts at different universes, so it is again not surprising that the world we know about comes to be the way it is. On the other hand, if one already believes in God on other grounds, say on the basis of religious experience, then the simplest explanation is in terms of a Designer God. For religious believers, such an explanation introduces no fresh assumptions at all, over and above what one already accepts as the explanation of other features of one's life.