

The Physics of Gravity - This is the Shape of the Universe, *and the bodies therein.*  
(Redacted before 2025)

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## Shape of the Universe Introductory Video

VOICEOVER:

“My name is Martin Cross, and I want to tell you the Shape of the Universe.

If it is before 2025, I want to tell you, but I cannot. Unless or until you attend one of my live talks.

I can, and will, tell you how Gravity works. I’ll tell you this below (See *How Gravity Determines Shape*), but I warn you: you may be shocked at how simple it is!

I *could* tell you how the Milky Way gets its spiral arms



that is, I could tell you, but again, I promise not to, ‘til 2025.

This is so you can work out for yourself. Then *you* can tell *me*.

The Shape of the Milky Way is a great example of something that usually is given a really complicated answer that only a specialist would know is wrong or right. Like the one here quoted in New Scientist:

<https://www.space.com/24642-spiral-galaxies-milky-way-shape-explained.html>

But I included my answer to this question in my first ever ‘Shape of the Universe’ public talk given in 2014. It only took a few minutes to demonstrate and it is the same answer I will give now.

So that's your “homework”, and this essay is my attempt to give you everything you need to work out the answer, just like I did.

Because it is just as shockingly simple.

## Introduction: INFINITY

Learning at Work Day happens annually in May. Back in the late 2000s I took the opportunity to present my lecture on ‘The Shape of the Universe’ to a group of local small business people. I was confident I could ‘market’ it: who hasn’t wondered what is ‘outside’ the Universe? I think people who run small businesses are generally pretty smart. I thought they’d be a good open-minded but sceptical group to test out my presentation, and they were my peers in the way that a more academically educated audience might not be. I started by asking them that question, “What is outside of the Universe?”

We’ve all, I dare say, had occasion to muse about what is beyond ‘everything’. Does it all stop at the edges, to become surrounded by ‘nothing’? But how then can ‘nothing’ be something? Or does it never end, becoming more and more and more? But if it never ends; if everything there is, goes on changing into more and more of what can be, and will be, then doesn’t that make a nonsense of what ‘is’?

I had a different answer, as I wanted to explain. My talk seemed to go down quite well. I felt people had been entertained, and that they had seemed to understand what I was presenting.

What was my answer? Well, using the example of Pi as infinitesimal rather than infinite, I tried to explain that the Universe does indeed have an edge, but it is an edge that extends infinitesimally, in a very specific way, the same way that Pi extends its digits forever, with no repeat.

Here and now I observe that, although surprising, there is nothing inherently worrying or upsetting in the behaviour of Pi. One does not go around looking for answers to impossible questions in the digits of Pi. One does not try using them to contact the recently deceased. Most of all, there is no temptation to worship the digits of Pi. They are wonderful, but they are not God.

As I said in my talk, figuratively speaking, you can reach the edge of the Universe very easily, but it is an edge that doesn't stop, just as there is no last or repeating digit of Pi.

~ • ~

One of the TV programmes that I fondly remember from the past was 'Tomorrow's World': Three knowledgeable presenters providing viewers with a summary of what's new in the world of science and tech. I am probably prone to the passed-middle-aged malady of gilding the past, but I remember it for combining a no-nonsense delivery with a great 'feel-good' follow-up. There is always plenty of bad news, but the science magazine show presented what you could not help but feel was *good* news.

Much later on, I made myself a web page containing RSS feeds and I happened to also include the 'New Scientist' RSS feed. I quickly made the discovery that this supplied me with a similar feel-good sense that 'Tomorrow's World' once did. In 2004, it took my breath away to see the Shape I had given to the Universe appear in an item in the feed from 'New Scientist'. When I saw my shape reproduced and 'brought to life' as an image through their site, that was the turning point which prompted me on to the web in own right.

I have got some free content to give out to people who don't want to, or cannot, attend the talks or that want to prepare in advance for attendance. As well as the website I have set up, [www.WhatIsTheShapeOfTheUniverse.co.uk](http://www.WhatIsTheShapeOfTheUniverse.co.uk), there are the essays which I have written and even a full-length book. All of this is free of charge at the moment \* ***and will continue to be so*** \*, as I make that promise, on record.

The work for this, and for the first talk had sprung specifically from a book I read in the nineties. In describing the mathematician Paul Erdos ("The Man Who Loved Only Numbers", Fourth Estate), the author had presented the work of Georg Cantor, on Infinity. Cantor was, I felt I could show, demonstrably wrong (of which more, shortly).

You'll already be familiar with my presentation of this idea if you have read the maths essay I wrote for a general readership, "Do You Like Numbers?". Not to worry if you haven't. The current essay does not assume any knowledge other than standard GCSE understanding.

Talking to my peers in business had been one thing, talking to the academic community – and specifically, physicists – would be quite another. If I were talking to a group of physicists, they would definitely understand the idea – but would they see it as a big idea? It is one thing to say to some one who has never thought of it, here is a way to look at things. It is quite

another thing to say to people who have spent their whole life looking at something to say “here is another way to look at it”. I could see I might have a different problem.

I might need to do a bit more work than that, so was there another way in?

The earlier article ‘Do You Like Numbers?’ had been intended to engage the child or teenager by sharing a non-mathematicians enthusiasm for numbers. At the same time it had a serious experimental purpose. I hoped to pre-empt what I saw as a young person’s indoctrination into a certain way of viewing infinity. But if the previous article describes how mathematicians should view Infinity, then how do physicists view infinity? Indeed, do they view infinity differently? The answer is I think, affirmative. And John Hurt explained how physicists view infinity to me – not personally, I must admit! It was in a recent BBC ‘Horizon’ documentary in which his magnificent voice was put to such good use.

The BBC ‘Horizon’ programme started by presenting the picture of a person at sea. They are in a boat and can see to the horizon all around themselves. The sea appears to stop at the horizon. There is a clear, firm line where it gives way to sky. But of course, we know that this is only an illusion: the sea has no such straight edge. It continues on beyond the Horizon until it meets the land even though we cannot see it, and for all we knew in the past, it could go on forever.

It is a good analogy for a couple of reasons. First, the horizon is caused by the curvature of the Earth and physicists know that space is curved by gravity. It is easy to grasp that they are both curved. Second, the boat is on, or in, the sea, not of it. It is water that extends beyond the horizon, not the boat or the observer. This is how physicists like to understand the Universe, externally, as ‘a bunch of stuff’ – the water.

Physicists might even say that John Hurt’s analogy caters for the nature of Pi, in a purely mathematical, one-dimensional sense; that they are about understanding infinity in three dimensions. Certainly the development of an idea of a shape for the Universe would normally be done using numbers; using maths; and I am not a mathematician. But the problem of the Universe is not logistical, it is conceptual.

Concepts like ‘the Big Bang’ and an ‘Expanding’ Universe lead us to think in terms of a center and an edge, but the Universe is a place with no centre and no outside; no edge. It *might* be ‘expanding outward’ but it is just as likely that it is ‘contracting inward’ because there is no frame of reference to make the judgement. An explosion might explain the movement of the Universe, but so does an ‘implosion’, and for the same reason. The cognitive dissonance this creates leads to misconceptions like Dark Matter and Dark Energy, ultimately leading to

notions which are not tenable like wormholes and multiverses. In my judgement this is because there is no objective third spatial Dimension - but we'll get to that. In summary, what is needed is not a mathematical formula; what is needed is a philosophical conception.

I had created my website, and I had seen the confirmation for my Shape of the Universe, but how could I as a non-scientist – a mere philosopher – shepherd such a view safely out onto the world ‘stage’?

That was the motivation. I created a talk for general members of the public, the one I am offering to people now, and delivered this for the first time in 2014. I was able to entitle it “This is the Shape of the Universe (or your money back!)” as I do now. I was thrilled when a majority of the audience of strangers was not just open but persuaded, as shown in [this Youtube video](#)<sup>1</sup> taken live at the time.

I would go on to develop these ideas into a “theory of everything – and everyone!” A full-blown philosophy, if you will. But that was much later, taking us almost up to today. Back in 2014, I had not yet presented on the ‘city stage’, let alone nationally. Before I could take the next step, what I needed was an essay like the one I had done for ‘Numbers’.

I wrote the first version of this essay in 2015. It was quite similar, but much shorter, than it is now. You may already have noticed how discursive this version is. That is because I am equally as interested in entertaining you (and myself) as I am in informing first myself, and then you. But there is another reason why Version 2 is quite different to Version 1.

I'd started writing ‘Numbers’ because I had read something that I knew was wrong (Cantor’s proof). That hadn’t happened in physics. The New Scientist picture had encouraged me because it was mostly right, not mostly wrong. I thought I just needed to persuade physicists who were mostly right that they could be completely right. I had no reason to think that physicists were wrong.

I had to wait til 2019 for that. It was the book ‘What If?’ by Randall Munroe from the xkcd website. Randall isn’t a physicist himself, he’s a science writer like the Fourth Estate biographer. That gave me a level to pitch for, and so the entertainment commenced.

Just like in my talk, which also starts with infinity, this essay proceeds by discussing Dimension; the Dimensions of space. We then proceed on to movement, and Gravity, the key part of the essay. We contrast the idea of a field against Einstein’s analogy of acceleration in a

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1 [https://www.youtube.com/watch?v=5SrqXq8c\\_7A](https://www.youtube.com/watch?v=5SrqXq8c_7A)

lift to develop the principle of a lift with a 'soft floor', as the basis for visualisation. I'm also using the book 'What If?' in this essay as a first foil to my own idea; I'm then using the Internet generally, as a second adversary to my position so as to give you the basis for yourself addressing the 'homework' (you could skip straight to it and read just this if you don't need or want any background). There is the further opportunity here to develop more than could be included in the live talk and so I include discussion of the conceptualisation of Time. I come back then to concrete examples, showing my idea of Gravity as an extension of existing knowledge, and finally to the question of proof.

Let's have a closer look at the content I am offering entirely free of charge at the moment.

Of course there is the first essay, 'Do you like Numbers?' That's the title for just 10,000 words that you can download as a PDF from my website. It is a shame to have to give away the 'spoiler' for it as I have already done but I am sure you will find it entertaining even knowing the denouement, as long as the answer to the question is affirmative: you do like numbers.

[http://whatistheshapeoftheuniverse.co.uk/2\\_Maths/Do%20You%20Like%20Numbers.htm](http://whatistheshapeoftheuniverse.co.uk/2_Maths/Do%20You%20Like%20Numbers.htm)

Also on the website as well as a number of other roughly 10,000 word essays, there is - completely free again - a full-length, full colour, illustrated PDF version of a book I wrote about the mind. This is the other part of my *theory of everything – and everyone* as alluded to earlier and on my Youtube Channel

It is a full 100,000 words, an exploration of that idea, as logically and exactly as I thought it could be done using philosophical principles and visualisation rather than the proof and maths of hard science. In a nutshell, I believe it shows the definition of the shape of the Universe is also the basis for a definition of mind.

[http://www.whatistheshapeoftheuniverse.co.uk/0\\_Common%20Sense/Common%20Sense%20-%20The%20Philosophy%20of%20Psychology.pdf](http://www.whatistheshapeoftheuniverse.co.uk/0_Common%20Sense/Common%20Sense%20-%20The%20Philosophy%20of%20Psychology.pdf)

So you might say why, if this work has any value, are you having to give it away free of charge? Why would I do that? And indeed, I'm not Facebook! I'm not grabbing "market share" so that I can make money. That's very much not the intention and I'll talk about that a bit later if you stay with me that far.

Now, what is a Dimension?

**Figure 1** *The many-dimensional illustrations of Steve Ditko, for Marvel Comics 'Dr Strange'.*



## Part A: SPACE

Draw a line through any two points in space. Does that represent a dimension - or a direction? In a Universe with no background and no centre, the direction you chance upon might be 'inward', or it might be 'outward' which is just the converse of 'inward'. The technical difference between a Dimension and a Direction is that Dimensions, such as those of space: height, width and breadth, are generally accepted to be orthogonal to each other. I wouldn't argue with that although as we shall see, that may not be the whole story.

Time is usually considered the fourth Dimension (see the next section), but the 'fifth dimension' of popular culture is closer to the idea of orthogonality. You can still see Rod Serling's 'The Outer Limits' on TV. As in many other stories, the 'fifth dimension' is one you can reach just as easily as by stepping through a door. Wouldn't that be great? Just as Serling's 'fifth dimension' is much more exotic than the world we know and have fully mapped, how we could conjure with, say, a ninth dimension!

The 'portal to another world' has been inspiring awe in children for generations, from C S Lewis' world of Narnia, through the wardrobe, to another Lewis: Lewis Carroll's 'Through the



Looking Glass', and on to Harry Potter. It very much helps if we can keep a strong visualization of these ideas. To describe things visually is to understand them, the way clever people understand numbers by using them through formulae. Even the simple visualisation of a boat at sea gives a useful starting point. The best visualization I can think of does come from my childhood, and I want to draw our attention to it now. It comes from the world of comics, by the artist Steve Ditko.

To digress briefly, I first started reading comics as a teenager. This medium of the imagination was to feed my sense of wonder for my whole life. As an adult, I could be left cold by Tate Modern and Damien Hirst, but I could be moved to a gasp by comics, as I was when I first saw the covers of Dave McKean, for 'Sandman'. As a teenager, my father had made me burn my collection of pornographic magazines after my mother discovered them under my bed. Some of these erotic images live fondly on in my memory today, but they are alongside the beauty of Marie Severin's images, for Marvel. This colleague of Steve Ditko showed me, for example, what it might look like if a man was strong enough to scoop up a castle by its corner (the Hulk), and teased my imagination with images I couldn't even try to describe to you now (Zom, The Living Tribunal).

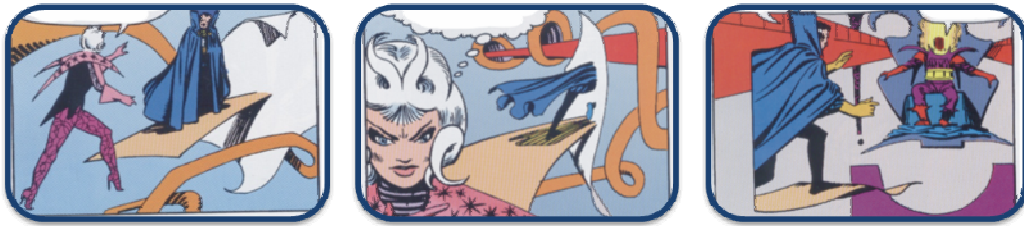
(I cannot resist adding, whilst we are talking about dimension, that of course the comic page is a 2D representation of 3D. Think about the attraction to the artist of the ease with which one can draw a stretching limb (Mr Fantastic, Plastic Man) or a man picking up a castle by its corner (Hulk) or a man shrunk to ant-size or grown to giant-size. These tasks were rendered far easier by drawing on the flat page than they could possibly be in three dimensions – at least before CGI. But then think about the challenge to pure imagination in putting these to story).

When at last I had the chance for my own essay entirely on this subject, I set out to write what I had always wanted to read: just one typical fans experience of the art-form for posterity. But of course there is a serious point to be made as well on behalf of a theory of everything and everyone about the psychological principles that perhaps underlie an extraordinary success. The resulting essay is free of charge below.

[http://whatistheshapeoftheuniverse.co.uk/6\\_OtherResources/Art%20-%20An%20Essay.pdf](http://whatistheshapeoftheuniverse.co.uk/6_OtherResources/Art%20-%20An%20Essay.pdf)

Marie Severin illustrated Dr Strange, amongst others, but it was Steve Ditko who was the co-creator and artistic force behind this character, a 'Master of the Mystic Arts'. Ditko's first stories showed Strange routinely travelling through portals he was able to open to other

worlds and dimensions. The illustration below shows Strange traveling through the portal he is able to open to a place which appears to be many-dimensional.

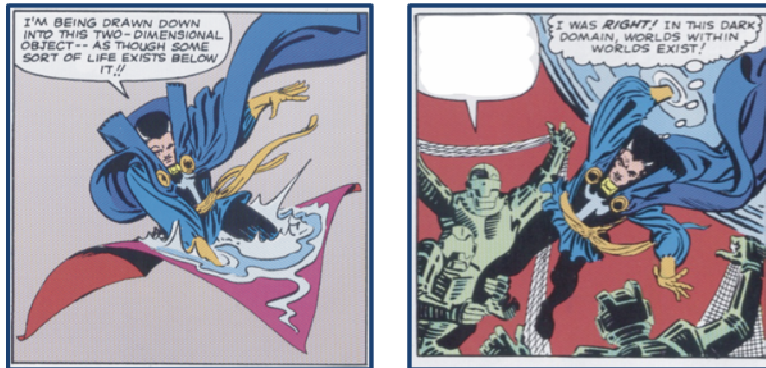


*The Marvel comic-book character Dr Strange travels through what appears to be a two-dimensional shape apparently having a different third dimension, acting as a shortcut, in this 'world'.*

Ditko then reveals to us, in all its glory, this world? - space? area? Universe? - notice how the visualization is so strong it challenges us to find the words to match it. The creators, Stan Lee and Steve Ditko himself, came to describe this as a 'realm', or 'domain' ( *the Domain of Dormammu, the Domain of Nightmare*), recognizing that the normal terms like 'country', 'world' or even 'dimension' did not match the intuitive and logical sense of what I will be calling poly-dimensionality. But that is to come.



As the story progresses, Dr Strange is attacked by minions of the ruler of the domain he has entered.



Intriguingly, they can attack him through portals of their own devising. It is as if they can create or at least access the dimensions in which they are almost next to Strange, and have only to take a single step to be right beside him.



*Dr Strange is a Master Sorcerer – a ‘Master of the Mystic Arts’*

In describing these sub-dimensions of course, I am imposing my verbal understanding onto a visual storytelling. Ditko might respond that it is 'just magic' (and I am overcomplicating it).

In long-established metaphysical thinking, Heaven is a place rather like 'the Fifth Dimension'. Although it is a place one can never visit physically, it exists alongside, and in addition, to the physical plane of the Universe. Even now, there is no reason that we know of that 'the Heavens', which is to say the stars, could not actually contain Heaven. You certainly cannot visit the Sun physically, as you cannot visit Heaven physically; it is 'up', being gravitationally at the centre for us, as Heaven is likewise 'upward'; and it is composed of plasma, a fourth state of matter with different properties than either solid, liquid or gas, as Heaven is a different place.

Personally, I would not argue for Hell as a place that really exists, and it is not my hope to convince you here that Heaven does either. But I have personally benefited from the principle that Heaven is not a proposition to 'reward good children' but a serious mystery that repays adult individual consideration. It turns out there is, after all, 'something to know'. As a subject, it became my first free essay.

[http://whatistheshapeoftheuniverse.co.uk/3\\_Religion/Religion.htm](http://whatistheshapeoftheuniverse.co.uk/3_Religion/Religion.htm)

If you don't read this, what I really want now, is to draw your attention to the long-standing terminology that Heaven is 'onward' and 'upward'. Whether your view is that the corollary of 'onward and upward' is 'backward and downward', or whether you share my view that is actually 'stationary', the point is that this is a two-dimensional characterisation of the larger metaphysic.

We make use of this dimensional meta-simplification all the time. Leaders no longer speak of onward *and* upward, but of 'the way forward'. When they do, it is not in comparison to the way left or even the way backward, it is really in comparison to the way *not* forward, i.e. at a standstill. In psychological terms also – that is, in the metaphysical world of the mind – we speak of 'moving on' in the same sense.

Why does this matter? Because I say, there is a tension between what is known and what is believed. As I write these words, the New Scientist has the cover below.



Here is how the article begins:

*"THE ONLY way is up." An earnest student of our physical realities might find room to dispute this jolly phrase. There is also down, and, for that matter, left, right, forwards and backwards. Six ways to go. Then again, the further up you go, the less down you are, and similarly for left and right, forwards and backwards. So that's three independent directions to move in – gravity and local obstacles permitting.*

*It is a fact so bald that we rarely stop to ask an even balder question: why?*

*Physicists have wrestled with this perplexing question of space's essential three-ness for a good while now – not, it must be said, with much success. Our best theories of nature supply no clue as to why space might have three dimensions, rather than two, four or 5.2.*

I'd like to read the rest of this article but for its notoriety rather than its implication. (The New Scientist is good news but it is not always free of ideological spin).

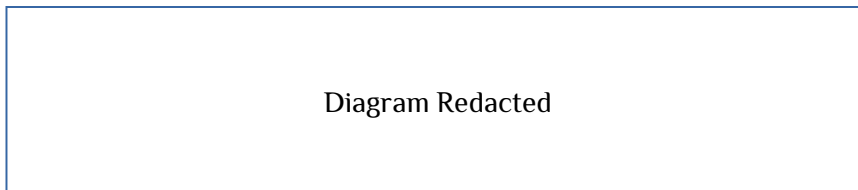
Of course physicists are the ones who have taught us that we cannot simply talk of three dimensions. They have taught us 'space-time', and that time is a dimension. We have all become reasonably comfortable with that. Although impossible it has been exotic, rather than threatening, to think of traveling backward in time. It is physicists who have pushed on to ask

if there are more than these four dimensions and in recent times some physicists have suggested there may in reality be as much as *eleven* dimensions.

What we know for sure is that the Universe is infinite, and the number of dimensions it has is infinite – or in my terminology – infinitesimal, like the digits of Pi (and for the same reason). We have not found any dimension is more important than, or even as important as, the three we usually consider: not even time. All the directions of space are a product of three dimensions in the same way all the shades of colour can be defined as some combination of a mix of red, blue and green - or another colour model.

Yes, the Universe is many dimensional but let's refer to it as no more than that. Let's refer to the Universe as poly-dimensional.

Now I can tie together the physics and the maths with a useful definition. When I was at school I was taught to use an oblong symbol for the Universal set, but I can redraw this more accurately, I think:



I use a thick perimeter to indicate that the set has an infinitesimal boundary – it goes on forever and ever getting smaller and smaller, so this more accurately describes mathematically and visually what is trans-finite, i.e. connected to infinity, like Pi, e, me, you and the Universe.

So how is the Universe *physically* infinitesimal on the largest possible scale i.e. at the edge?

The screenshot shows a New Scientist article page. At the top, there is a navigation bar with links for 'Space', 'Technology', 'Environment', 'New Scientist Jobs', and 'Subscribe to New Scientist'. Below this is the 'NewScientistSpace' logo and a search bar. The article title is 'Galaxy map hints at fractal universe' by Amanda Carter, dated 01:00 25 June 2008. The article text begins with the question: 'Is the matter in the universe arranged in a fractal pattern? A new study of nearly a million galaxies suggests it is – though there are no well-accepted theories to explain why that would be so.' A large image of a fractal galaxy cluster is shown on the right. Below the article, there are 'Related Articles' and a sidebar with various categories like 'Home', 'Stories', 'Blog', 'Video', 'Solar System', 'Space Technology', and 'Human Spaceflight'.

The New Scientist had a headline in 2008 (“Galaxy hints at fractal Universe”) in which the article began with these words:

*Is the matter in the universe arranged in a fractal pattern? A new study of nearly a million galaxies suggests it is – though there are no well-accepted theories to explain why that would be so.*

The article goes on to explain:

*Nearly all physicists agree that on relatively small scales the distribution is fractal-like: hundreds of billions of stars group together to form galaxies, galaxies clump together to form clusters, and clusters amass into superclusters.*

*The point of contention, however, is what happens at even larger scales. According to most physicists, this Russian doll-style clustering comes to an end and the universe, on large scales, becomes homogeneous.*

Here is what Wikipedia says about fractals:

*A fractal is a mathematical set that has a fractal dimension that usually exceeds its topological dimension and may fall between the integers.*

You’re familiar with a fractal from the example of a coastline. As you know, you can ‘zoom in’ indefinitely on a fractal pattern and always see more detail. Mathematically, I would say, a fractal is a set with an infinitesimal perimeter. Because you have already seen it in the case of

Pi, you know how an infinitesimal number can continue indefinitely without ever repeating. You also know that Pi is a practical number with limited usage. It may be the work of God but it is not infinite; it is not God.

In exactly the same way, you can 'zoom out' on the Universe (of which we are all part), and always see more detail; but what you are looking at on these largest scales is the edge of the Universe which continues without repeat – but perhaps even meaninglessly<sup>2</sup> – forever, as a fractal.

It is what you might expect to see at the horizon of space.

~ • ~

Now that we are here at the edge of space ok, let's look back to our starting point (see page 7), the technical difference between a Dimension and a Direction is that Dimensions, such as height, width and breadth, are orthogonal to each other.

The easiest way to conceive of the Universe is as a sphere, so let's begin with that.

This is interesting: We can conceive of the sphere as having a radius of 13.8 billion light-years distance. That is because the Universe is 13.8 billion years old so we are told, and the speed of light is the limit. You may also know that the observable Universe is 46 billion light years from end-to-end. The conventional explanation is because space has expanded during the time being measured, but is that right?

We are told that space is expanding but because there is no centre there is no frame of reference to determine whether it is expanding or contracting. Both are equally good interpretations of the observation. And if we were to say space is contracting on the largest scale then at some point it would come into balance.

I draw no conclusion other than to say that we need a starting point we can understand and so I propose the sphere. The Internet tells me the furthest you could travel at the speed of light, allowing for 'expansion', is 14.5 billion light-years. Although they don't match exactly, I'm happy those figures are close enough to allow for experimental error (!) So my sphere would have a radius of between 13.8 billion and 14.5 billion. It gives us a basis for refinement.

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2 This is an important point. For all its appeal in fiction - unlike Time-Travel, which we come on to later - 'multiple Universes' is not a meaningful idea.



Let's go back to the idea of a sea as a concept for infinity. We now understand that we are on the surface of the sea with a horizon that is between 13.8 and 14.5 bly ( billion light-years) away all around us. We understand why this sea has no exact edge – because it is infinitesimal - and our position on it is entirely by chance: there is no objective centre.

In other words, our visualisation – our map – works for two out of the three Dimensions. If we want to move in space we can do so but we are moving on the surface of the sea. Unlike Dr Strange, we cannot go below or conversely, lift off from, the surface.

We've talked a lot about a fifth Dimension, enough to be fairly sure that if there was one, we would know it. It seems unlikely. I said that Time is the fourth Dimension and indeed, Time is both well understood and poorly understood, which gives me a golden opportunity to deal with it in a separate section on its own, below. An example is that, beloved as it is of fiction, nobody really thinks that time-travel is possible, and yet it is a proven aspect of physics (see Feynman's book, and below). Be that as it may, for you or me, time travel is not possible. Time is not in reality a Dimension.

But we measure our distances against speed – the speed of light. Could speed be a Dimension? (Not really, I thought. What then about a dimension of *scale*?)

In point of fact I have already pre-empted myself. I have said that there is **no** third Dimension! But I haven't justified that yet; there is a different possibility still to consider.

What about gravity? Could gravity possibly be a Dimension?

VOICEOVER

How does gravity operate at the centre of the Earth? Let's Google to get the answer!

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