Chapter 13

The Starting Point

In theory at least, the singularity at the origin of the universe was akin to a single point, and from EA Abbott's mathematically correct visit to Pointland we learned that a 0-Dimensional entity would have neither length nor width nor height. So what would it have? Well, nothing really, or at least nothing that it couldn't contain within the 0^{th} Dimension. But if the 0^{th} Dimension is represented in our 4-Dimensional world of space-time by a point, that doesn't really leave much room. But how much room does it need, because 'room' is a 3-Dimensional concept.

And why should we impose *our* experience on the 0^{th} Dimension?

We have already established in our discussion of representations that an ink dot on paper is not 0-Dimensional, but 3-Dimensional (or 4 if you include time). It's just a *picture* of the 0^{th} Dimension and might as well hang in an art gallery – which it already does (several apparently) in the form of the stirringly minimalist classic, *Black Dot on a White Canvas*. So, since a painted dot is simply a *representation* of the 0^{th} Dimension, what we have to exorcise from our minds is the 3D objection that a great deal could not be contained within a single point. The same goes for black holes. It may be helpful for us to consider them for a while, if only for contrast…

Mr Neutron Strikes Again

US physicist John A Wheeler described the black hole – a term of debated origin popularised in the late 1960s – as a *'gravitationally completely collapsed star'*; an exceptionally massive star which, when its fuel supply runs out and with it all the energy pushing outward toward its surface, can no longer sustain the weight of its own mass under gravity and collapses in on itself. Not all collapsed stars become black holes – neutron stars share a similar fate but without the disappearing act. The NASA website tells us that a neutron star is,

> *'…about 20 km in diameter and has the mass of about 1.4 times that of our Sun. This means that a neutron star is so dense that on Earth, one teaspoonful would weigh a billion tons!'* [a]

Gravity's strength at the surface of a spherical body is related to two things: the mass and radius of the body[b]. The kind of collapse we are talking about here is not anything in our earthly experience. Atomic nuclei are forced to jam pack together, giving us the term 'neutron star', and since atoms start off as 99.9999% empty space this will reduce a star to the size of a small mountain.

In 1915 – incredibly whilst serving with the German army in WW1 on the Russian front (where he sadly died) – a brilliant astronomer named Karl Schwarzschild came up with precise solutions to Einstein's equations[c]. Among these was his discovery of what is now known as the Schwarzschild radius. An item on the website of Princeton University (where his son Martin was Professor of Astronomy) described the Schwarzschild radius as, *'the effective radius of a black hole; the point of no return'*[d].

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[a] http://imagine.gsfc.nasa.gov/science/objects/pulsars1.html - Accessed 11th Nov 2016

[b] Objects in space larger than the asteroids tend to be spherical because the effects of gravity overwhelm the strength of the material from which they are made.

[c] Much to Einstein's surprise as he believed them only to be approximations.

[d] http://www.astro.princeton.edu/~anatoly/ast203/Lectures/Lecture_19.html - Accessed 11th Nov 2016

As a star collapses, its radius reduces whilst its mass remains the same, consequently the effect of gravity at the body's dwindling surface increases, causing the escape velocity to rise dramatically. A point is reached at a certain radius where the escape velocity exceeds the speed of light and, because nothing can exceed the speed of light, not even light itself can escape. This, the Schwarzschild radius, is commonly known as the 'event horizon' and is the reason the black hole is black (effectively a hole in space-time). It then meanders through space devouring the cosmos. The Schwarzschild radius of the Sun is around 3 kilometres, although for the Earth to become a black hole it would need to collapse to the size of a pea!

Mathematician Marcus du Sautoy tells us in his book, *What We Cannot Know*, that the question of what goes on inside the event horizon of a black hole has an answer, but it can only be known from the inside, because *'if you are outside the event horizon, you are denied access to the answer by the laws of physics.'* [a]

"Yikes! A black hole."

Two of a Kind

According to Relativity, the centre of a black hole contains a singularity where Einstein's gravitational curvature of space-time dive-bombs into a 4-Dimensional tube. In there pretty much everything goes infinite. This is of course a theoretical product of the maths (and likely to remain so due to the practical difficulties involved in setting up a lab experiment) although many scientists now believe that quantum effects might mean the centre is in fact finite. This would be handy mathematically because infinities tend to mess with their equations. At last… a quantum effect that makes something simpler!

However, the black hole singularity is a very different entity to the Big Bang singularity at the instant of creation. Apart from the difference in scale between the two phenomena, the black hole singularity acts *inwardly* whilst the Big Bang was the opposite. At this juncture you may (or may not) be wondering… *'if the Big Bang was so big, why didn't it collapse into a black hole of its own making?'* According to Einstein's equations, the Schwarzschild limit does not apply when matter is expanding rapidly. Instead our universe cooled down into a set of universal laws which, in a cosmic 'night of the long knives', oversaw the suppression of any future rival super-massive accumulations of matter by consigning them to black hole prisons and throwing away the key.

The Pinhead and the Pea

If the Big Bang could be said to have had an 'event horizon' it would also have been the 'physical reality horizon' because nothing outside it existed, which would suggest that, when fully expanded into the actual size of the universe today, this 'physical reality horizon' is still out there somewhere, corresponding

[a] Marcus du Sautoy, *What We Cannot Know*, 4th Estate 2017, P283

to the edge of the universe as imagined by children. However, as we saw in Chapter 9, there exists no such 3-Dimensional edge. And if there is no such edge now, *there was no such edge then*, either.

So, although scientists talk about the universe in the first nanoseconds of the Big Bang being smaller than a pea – or even a pinhead – they cannot mean its physical diameter because, although it observes principles of sphericality, it is not a sphere but a hypersphere. Therefore, unless we can somehow imagine 4-Dimensional 'hyper-peas' and 'hyper-pins', the *pinhead and the pea* analogies are all visually inapplicable. Physicists are simply plying us with dimensionally lower analogies which we can visualise; however, this is rarely explained, and therefore to an extent confusing and unhelpful. The singularity 'pinhead' would have been an 'everywhere-pinhead' rather than a 'somewhere-pinhead', and if you could have been there, inside it, the universe would have looked just as 'everywhere' as it does now. Ludicrous as that sounds *it has to be true*.

A Whole Lotta Nothing?

So, tempting as it is to think of it as 'our 3-Dimensional universe', the universe is a 4-Dimensional entity and we must be careful to remember this. Because of its relationship to time, the whole dimensional structure is intermeshed in ways that we cannot comprehend, far less unravel! Expressing this idea, Einstein called his 4D continuum *'objectively unresolvable'*.

In Chapter 3 on *Stacking* we saw how one dimension is built up from the last – as per *Sphere's 'infinite number of Circles'* – and as a logical consequence we were able to sum it up in the *Principle of Stacking*[a]. So, following the logic, the 1st Dimension must be composed of 'an indefinitely high number of cross-sections' of the 0th Dimension. Ok, now we have a problem. In all our dealings with the reason and logic of Dimensionality we have not yet been required to multiply by zero! Well, now we have.

Or have we..? Because the 0th Dimension is a *thing*, not a non-thing. The dimension itself may appear to be zero but *it is not nothing*. Perhaps in the same sense as the Zeroth Law of Thermodynamics, the 0th Dimension is simply the dimension below the first. And although it possesses zero degrees of freedom, it isn't going anywhere anyway. True, the 0th Dimension has zero dimensions as we understand length, width and height, but this is meaningless if we consider that length, width and height may not be what dimensions *are*, but merely three of the concepts we have at our disposal to logically represent them. Dimensionally then, zero is another one of our concepts.

Clearly it is beyond the scope of the human mind to conceive of a 0-Dimensional point. To all intents and purposes, zero means zero means zero. However, on the plus side, if we are mentally incapable of conceiving what it is that goes to make up the 0th Dimension, but something does make it up, then it could be anything! Suffice to say it was *something*, because it stacked up to form the 1st Dimension, which in turn stacked up to form the 2nd and so on… which would imply that *the singularity is what everything is made of*.

Science's enigma may be philosophy's darling. The point singularity, as the 0th Dimension, may be *the* most fundamental entity in existence[b], and although we are looking here at the nature of the singularity mainly from the point of view of dimensional logic, it may be helpful to understand that, as far back as the laws of physics can reach, the stacking principles involved are not in any way at odds with the scientific

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[a] *The Principle of Stacking:* Each dimension is composed of an indefinitely high number of cross-sections (slices) of the dimension below, stacked together and fused into a single entity.

[b] Unless we ask what stacks to form it. There is also the possibility that the structure may be in some sense 'book-ended', which could introduce theological arguments.

position. For example, consider this excerpt from the website, *Universe Forum*[a], produced for NASA by the Harvard Smithsonian Center for Astrophysics,

> *'A remarkable consequence of this [inflationary universe] model is that, if even a pinpoint of space contained this primordial form of energy, then the pinpoint of space would expand extremely rapidly and would bring into existence more of the same kind of energy. In fact, all the matter in the universe could have arisen from a bit of primordial energy weighing no more than a pea. This amazing scenario is a consequence of applying Einstein's theory of gravity to the inflationary universe model. Thus the known laws of nature can in principle explain where the matter and energy in the universe came from, provided there was at least a tiny seed of energy to begin with.'*

So, although no-one knows what it was or where it came from, modern physics allows for the possibility that an awful lot may have come from a very little. The singularity was the embryo of a universe, and we are the children of that universe.

The principle of the great from the small extends throughout the natural real – with even Christ relating that faith 'as a grain of mustard seed' could move a mountain – and just as a human being starts out from a single cell, it is not impossible that the universe may have stacked up from a single 0-Dimensional entity which corresponded to NASA's *'tiny seed of energy'*.

[a] http://www.cfa.harvard.edu/seuforum/bb_whatpowered.htm - Archival site accessed 27th Nov 2016.