Chapter 34

Book-Ends

Before we continue, let's summarise the properties and implications of the twin demisphere model so far (as there are plenty more to come!):

1) The 3D observable sphere is a cross-section of the 4D hyperspherical block universe, centred on each space-time event as observer.
2) The origin is located at *Centre A*, the 'north pole'; and the observer at *Centre B*, the 'south pole'; with these antipodes located at each space-time event.
3) The 2D equator acts as a shared spherical surface between the northern and southern demispheres, corresponding to the *'world radius'*[a] as described by Einstein in 1916.
4) Infinity is ruled out as the model is *'finite in the manner of the spherical universe'*[b].
5) The multiverse is superfluous as the universe is closed (compact).
6) The 'horizon problem' of superluminal recession and faster-than-light expansion of 'space itself' no longer apply. Nothing may exceed *c* as it governs the unfolding of the universe.
7) The Big Bang singularity is located at the maximum possible distance (*Centre A*), dimensionally projected by the 'Antarctica effect' across the surface of the observable universe.
8) The CMB is projected across (but just inside) the surface of the observable universe, again by the 'Antarctica effect', resulting in 'smoothness and homogeneity' without Cosmic Inflation.
9) Light may only ever travel a half-circumference of the universe with respect to the observer.
10) The true positions of distant celestial objects may be obtained by 'rolling the balls'.
11) An inverted 'ghost universe' must exist around the observer as the expression of 'back-light' and 'back-gravity'.
12) Recession of the observer (*Centre B*) from the origin (*Centre A*) takes place at *c* in accordance with Special Relativity.

It's plain to see that the model has much potential – and up to this point all we have looked at is the behaviour of light. Let us now turn our gaze toward gravitation, beginning with the mystery of expansion.

Space Itself

When the website of Georgia State University talks about the *'fact that the universe is expanding'*[c] they are referring to astronomers' measurements, derived by several different techniques and thoroughly checked using state-of-the-art technology by teams of talented individuals throughout the world, which show unequivocally that the universe is expanding.

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[a] Albert Einstein, *Relativity*, Section 31, Routledge 2001
[b] Ibid.
[c] http://hyperphysics.phy-astr.gsu.edu/hbase/astro/hubble.html - Accessed 9th June 2015

Reflection… Interestingly, Hubble's law does not expressly state that the universe is expanding, but instead carefully expresses Edwin Hubble's observations which relate to redshift. Hubble himself seems to have been troubled by its implications and to some extent reserved judgment on its cause. Einstein eventually accepted the expanding universe on empirical grounds although he remained uncomfortable with the notion of infinity.

Cosmologists also tell us that the universe is expanding at a rate which, over immense distances, is able to exceed the speed of light. Light waves out there are continuously being stretched by the relentless expansion of a thing that we think of as *space itself*. However, depending on the extent to which matter is gravitationally bound, matter itself seems unwilling to exhibit this expansion. Here is Professor Frank Close,

> *'As neither the solar system, the Earth, nor the atoms that make us are expanding, the received wisdom is that it is 'Space itself' that is growing.'* [a]

Amazingly, observations seem to indicate that galaxies remain at rest in relation to the immediate space around them but the space in between expands, and – as per the 'dots on a balloon' or 'raisins in a cake' analogies – everything just gets farther from everything else. On a large enough scale, the pattern of expansion should be the same (homogeneous) everywhere in the universe and is not thought, of itself, to dictate the global universe's shape, currently believed to be infinite.

Reflection… Frank Close's use of the phrase *'received wisdom'* suggests that he considers the problem of space itself somewhat of an open question.

The farther out we look, the more space expands away from us, but we are told that space does not expand *into* anything, such as some 'higher' space. In a sense the space in between is not actually anything, and scientists are simply using the term 'space' as a placeholder for something whose whole purpose is to define all the relationships between what is within it[b] (as per Descartes' *'no space without bodies and hence no empty space'* and Einstein's corroboration thereof, discussed in Chapter 16). This is reminiscent of an earlier quote from physicist Carlo Rovelli where he described the fundamental nature of reality as *'A world of happenings, not of things.'*[c]

The twin demisphere model – which is simply a spherical cross-section of a hypersphere centred on each space-time event as observer – suggests that what we are seeing out there in the observable universe is something playing out in the 3rd Dimension that is *actually going on* in the 4th. This view was also supported by our *Flatland*-derived *'Edge-On' Principle*[d] which serves to emphasise the extent to which our universe's appearance and function is observer-based.

Consequently if, as per the conventional view, we reduce our concept of expansion to the level of an objectively physical event going on 'out there' (the 'scientist's living room' approach mentioned in Chapter 15) and then compound the error by applying it, Dimensionality-free, to the global universe, we could be

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[a] Frank Close, *Nothing: A Very Short Introduction*, Oxford 2009, P4

[b] In spite of how easy it is for us to comprehend on a philosophical level the idea of empty space as simply 'nothingness', physicists tell us that the newly existent void is in fact seething with the quantum activity of energy and elusive particles. However, the fact that the void fills with activity as soon as it manifests need alter nothing of its dimensional genesis.

[c] Carlo Rovelli, *Seven Brief Lessons on Physics*, Penguin 2014, P31

[d] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.

missing something of great import. Jayant Narlikar sounded this alarm as early as 1977 in the final paragraph of *The Structure of the Universe*,

> *'Since laboratory experiments have guided the growth of physics over the two centuries, physicists are accustomed to thinking in terms of 'local' laws of physics… The application of these laws to astronomy has been through a process of cautious extrapolation.* ***This hardly does justice to the grand laboratory provided by the Universe as a whole****.'* [Emphasis his] [a]

Such far-reaching oversights are not unheard of in science; in the book *The Ambidextrous Universe*, Martin Gardner described the following historical gaffe,

> *'Although the notion of a fourth dimension had occurred to mathematicians, it had been quickly dropped as a fanciful speculation of no possible value.'* [b]

Let's look closer at what the dimensional picture has to offer.

The Classic Analogy

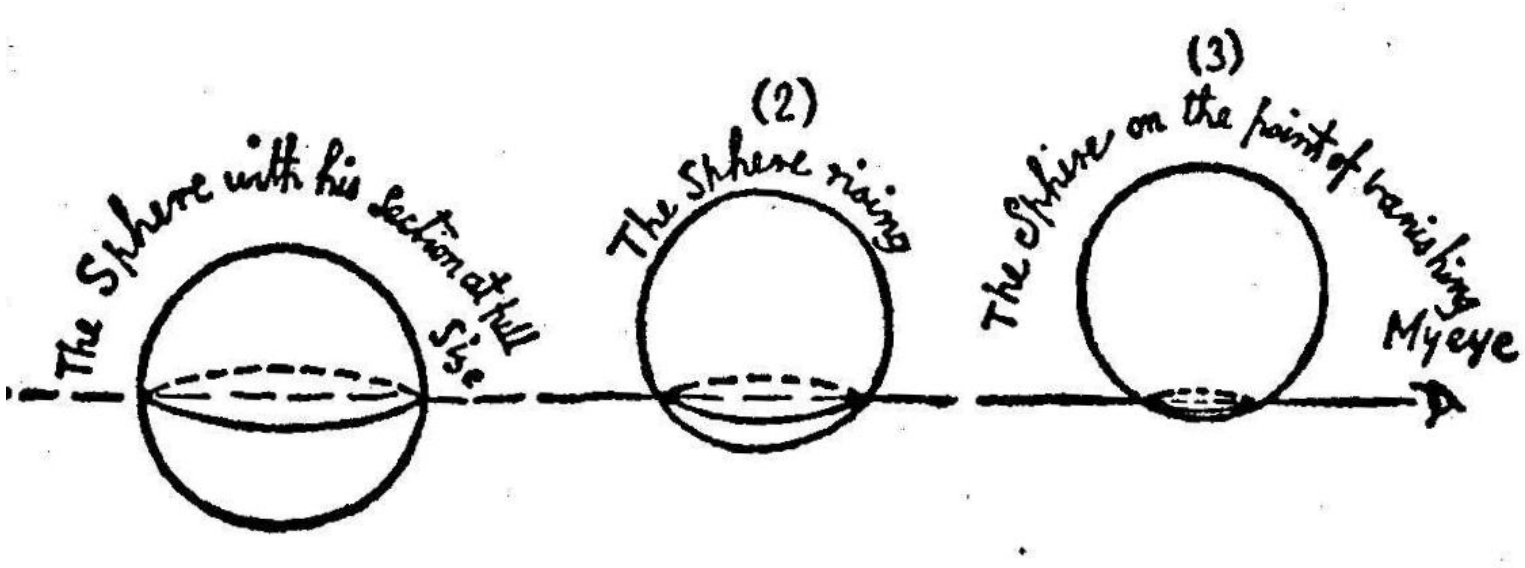

Fig.1 EA Abbott's original slightly squiffy drawing of *Sphere* cross-sectioning through Flatland, (shame he never drew round a penny). Note how *Sphere* himself remains unaltered, whilst he is viewed in cross-section from a dimension below – by *A Square's* eye, to right – as an entity which expands from a point to his 'equator', then contracts again to a point.

In *Fig.1*, EA Abbott illustrates a dimensional relationship. By contrast, in his *Flatland*-centenary book *The Fourth Dimension*, physicist Rudy Rucker tells us that,

> *'A widely held present-day view of the universe is that our space is an expanding hypersphere, which started out as point-sized…'* [c]

Considered in terms of dimensional principles, Abbott's illustration and Rudy's observation represent two very different, perhaps even contradictory scenarios. Let's begin with the latter:

In *Figs.2* and *3 (following page, to right)*, the completed hyperspherical universe is represented by the outer sphere. The Big Bang origin is at *A*, whilst *B1*, *B2* and *B3* represent the universe (i.e. *Centre A/B* recession) at stages 25%, 50% and 75% of completion.

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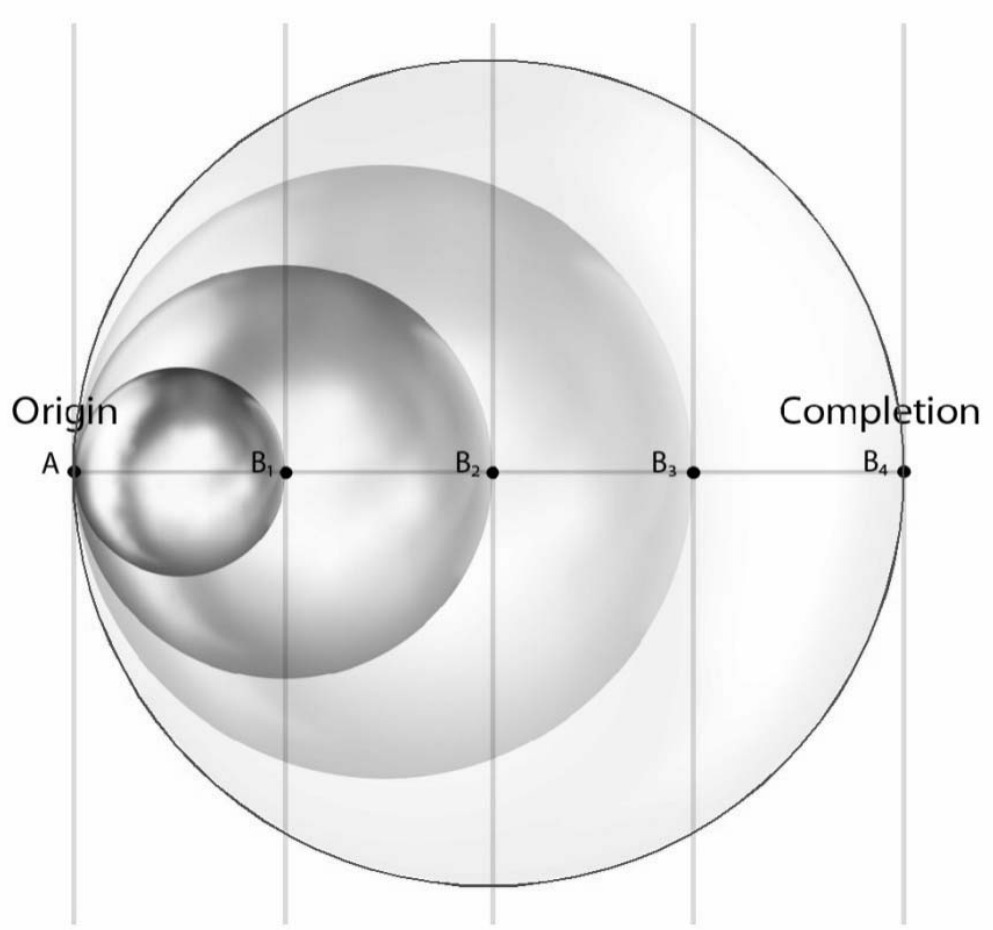
[a] Jayant Narlikar, *The Structure of the Universe*, Oxford University Press 1977, P249-50
[b] Martin Gardner, *The Ambidextrous Universe*, Pelican 1970, P159
[c] Rudy Rucker, *The Fourth Dimension*, Houghton Mifflin Company 1884, P162

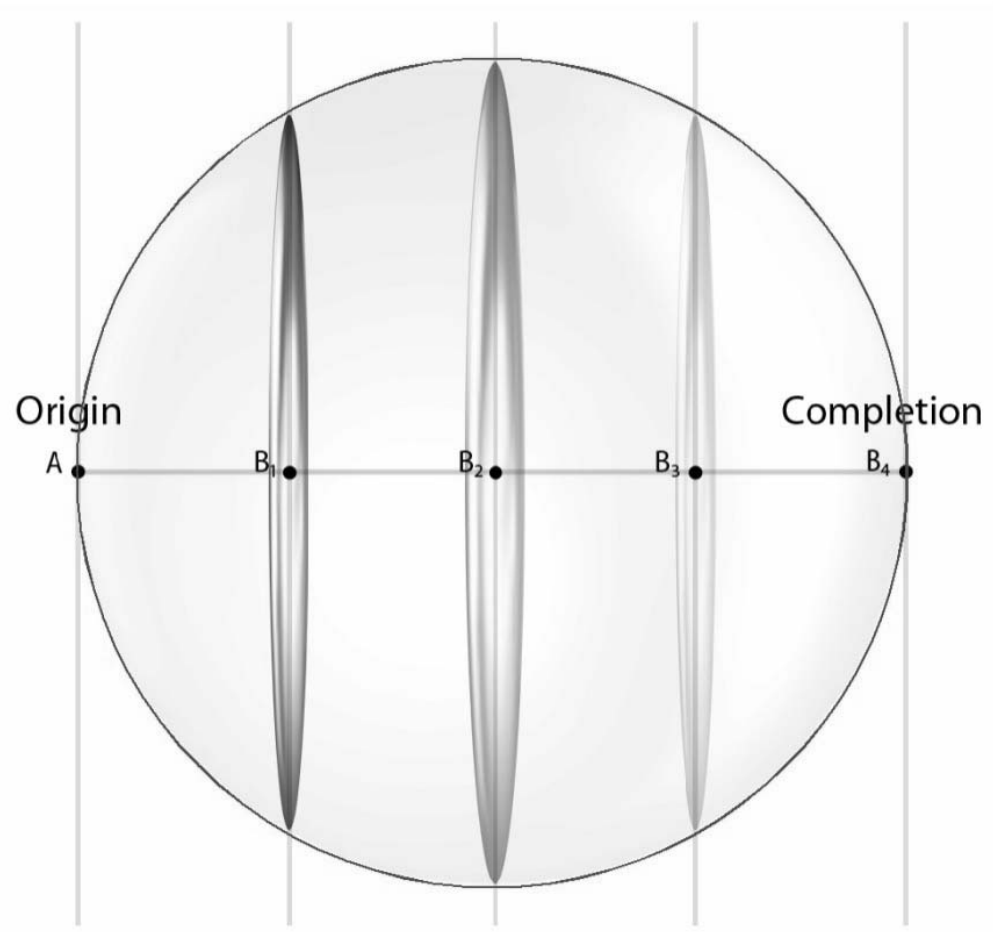
Scenario 1) The expanding spherical surface:



As per Rudy's '*widely held present-day view*' (in 1984), *Fig.2* illustrates our 3-Dimensional universe occupying the 3D hypersurface of an expanding 4D hypersphere. The hypersphere *itself* expands between *A* and B_4. Curvature takes place into the 4th Dimension. However, there are two problems with this model:

1) There is no reason why the ever-expanding hypersphere should stop at a particular value, and
2) It contradicts our *Flatland*-based principles which show how a dimension stacks up into the next dimension (e.g. the Principles of *Stacking*[a] and *Character*[b]). The expanding 4D hypersphere (if each may slice be considered discrete) should technically be stacking into a 5-sphere.

Scenario 2) The cross-sectioning disk:



The geometry of *Flatland* teaches us that it may not be necessary for a 4-Dimensional hypersphere *itself* to expand for us to experience a 3-Dimensionally expanding universe. This is very easily demonstrated by the analogy of *Sphere* passing through Flatland: as per Abbott's drawing (*Fig.1*), his cross-sections appear to *A Square* as a sequence of expanding then contracting 2D disks whilst his actual 3D existence as a 13-inch diameter sphere remains unaltered.

In *Scenario 2* – which reflects the *Flatland* analogy – *Sphere* himself is not required to expand, and, by extrapolation, neither would our hypersphere. The hyperspherical universe subsists as an unchanging entity – a block universe – whilst it is perceived by those who experience it one dimension lower (us) as a sequence of expanding or contracting cross-sections, like the flick of a cartoon. We view the universe *from within* in the process of stacking, just as *A Square* viewed the 'Circles' of *Sphere*.

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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] *The Principle of Character:* Once the stacking of a dimension is complete it assumes a whole new character. Its individual cross-sections fuse together and their discrete nature becomes indiscernible.

Because of our 'edge-on'[a] viewpoint, we experience a universe whose 3D shape and form are not fundamentally due to how the universe appears to us, but *how it actually is*, in 4-Dimensions[b]. Whatever this 4-Dimensional thing is that we represent by a hypersphere, *from our viewpoint* it appears incomplete due to the ongoing process of stacking[c] by which we view the 3rd Dimension – the first three nested hierarchical layers of the dimensional structure – melding continuously into the 'so-far completed' portion of the hypersphere we refer to as the past. Applied to the universe, the logic of *Flatland* may be very revealing, as the dimensional principles of *Flatland* indicate that the universe proper – the block universe – may in some sense simply 'exist', whilst *expansion is related to how the observer experiences the universe.*

Of course, none of this is to suggest that expansion is some kind of Zen illusion, devoid of actual heat or pressure – not at all, any more than Einstein's Relativity robbed time and distance of their physical reality. *An observer-based understanding of the universe does not preclude physical phenomena*. If correct, it should explain them.

Reflection… So where does this analogy leave the idea that the observable universe may be analogously compared to both the hypersurface *and* the cross-section of the hypersphere? As with the example of a sphere, the surface represents the boundary for all it contains. Therefore, although both are *n*D, the boundary is not the same thing as a cross-section. The boundary defines the geometrical region within which cross-sections exist, just as the surface of a sphere encloses the volume from which disks may be cut.

Although the physical universe passes us by in 3D cross-sections, the 3rd Dimension also represents the boundary of our moment-by-moment experience, from within which each expanding/reducing spherical slice is cut (see Chapters 9-11).

The Lesson of *Sphere*

Simply by assuming that 3D *Sphere* passes through 2D Flatland at a constant speed we derive a remarkable analogue of a 4-Dimensional universe passing through the 3rd Dimension[d]. (Note: the *Flatland* analogy is the converse of our natural, viewpoint-based inclination to think of the 3D present as moving through the 4th Dimension.)

Let's analyse this dimensional analogy in more detail by putting it into a table for comparison. *Sphere's* phases extrapolate up by one dimension to our universe as follows:

3D *Sphere* passing through 2D Flatland:	**4D hypersphere passing through 3D physicality:**
Sphere appears in 2D at a point.	The universe appears in 3D at a singularity.
Viewed in 2D, *Sphere* seems to emerge from nowhere.	Viewed in 3D, the Big Bang singularity seems to emerge from nowhere.
Expansion rate of area of cross-sectional disks at its	Expansion rate of cross-sectional spheres at its most

[a] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.
[b] The physical universe is a working combination of four mutually supportive and interactive dimensions. From this it is clear that everything that goes on within it is what actually comprises it,
[c] *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.
[d] This is *Centre A/B* recession at *c*. Sphere's entry point represents the origin at *Centre A* whilst the centre of his cross-sectional disk represents the observer at *Centre B.*

most rapid at the instant of appearance of the initial point.	rapid at the instant of appearance of the Big Bang singularity.
Disks increase in area but at a decelerating rate.	Spheres increase in volume but at a decelerating rate.
Disks reach a maximum area.	Spheres reach a maximum volume.
Disks begin to contract.	Spheres begin to contract.
Contraction rate accelerates as area decreases.	Contraction rate accelerates as volume decreases.
Contraction rate at its most rapid at the instant of *Sphere's* disappearance at a point.	Contraction rate at its most rapid at the instant of the universe's disappearance at a singularity.

Reflection… If *Sphere's* slices are <u>*all*</u> 2D disks, what kind of transformation would require to be involved in a process whereby the first and the last slices metamorphose from, and into, 0D points? This conflict expresses in *Flatland* terms something of the problem with singularities.

Congealing Black Holes

Clearly, from this comparison table we see that there exists a remarkably close parallel between *Sphere's* analogous descent (or as Abbott presented it, ascent) and the universe we observe. This is a good example of what I was referring to in the Introduction when I suggested that mathematics may have cast its net too wide, and…

> The time has come to have confidence in analogy, and thereby attempt to gain an understanding of why certain processes apply to reality where others don't.

There are many competing candidates for the end of time, but if EA Abbott's *Flatland* can describe by dimensional analogy the existence, action and 'book-ending' of 3-Dimensional expansion and contraction within a 4D block universe, what physically real form might we expect this to take?

In the absence of the guiding principles of *Flatland* and thus of any definite shape for the universe, cosmologists are not agreed that the universe should contract at all. They describe a range of potential scenarios of equal mathematical merit with no *a priori* reason for one to be preferred above another – instead awaiting a signal from the skies as to which is the one[a].

The continuing detection of gravitational waves through international collaboration led by specialist centres such as the Institute for Gravitational Research at Glasgow University and Caltech in the USA continues to show great promise, along with high hopes for the James Webb Space Telescope, scheduled for launch October 2018. However, we may already have received all the signal we need to construct the basis of a model in the form of the CMB, because it points to a direct 3D/4D relationship between the observable/global universe which may then be testable using these other technologies. Looking at the 'cross-sectioning disk' (*Figs.1* and *3*), the closest to the *Flatland* analogy is probably the most obvious and best known, in which a universe that began with the Big Bang ends in some kind of Big Crunch.

In Abbott's illustration, *Sphere's* slices begin at a point and disappear again at a point, therefore it is logical to suggest that a universe which expands out from a singularity could collapse again to a singularity. In its simplest form this is in keeping with our natural sense of the behaviour of something that expands and

[a] The Big Freeze, the Big Rip, the Big Crunch, the Big Bounce, etc.

then contracts, such as a football, or a lung. We may be inclined to imagine such a scenario in terms of galaxies shrinking, time running backwards and such like… but that is not necessarily what may be implied. The official *Einstein Online* website tells us that the Singularity theorems developed in the 1960s and 70s by Stephen Hawking and Roger Penrose…

> *'…prove that, in the frame-work of general relativity, every black hole must contain a singularity, and every expanding universe like ours must have begun in a big bang singularity.'* [a]

Penrose and Hawking showed mathematically that two kinds of singularities exist, with those which form at the centres of black holes as the *'time-reverse'* of the Big Bang singularity – what Penrose describes as *'initial-type'* and *'final-type'* singularities. He writes,

> *'The presence of such space-time singularities has presented physicists with a fundamental conundrum, often viewed as the converse problem to that of the Big-Bang origin to the universe. Whereas the Big-Bang is seen as the beginning of time, the singularities in black holes present themselves as representing the* ***end*** *of time – at least as far as the fate of that material that has, at some stage, fallen into the hole is concerned.'* [b]

So the 'collapse' of the universe may not be like the football which expands out, then contracts physically in again. Like rain from the sky that spreads out and disappears down a thousand drains, returning to the sky, but not by the same route, the completion of expansion/contraction's 'path', although circular in 4D, appears *to us* in 3D as linear. Roger Penrose illustrates something similar to this option for the universe which he calls 'congealing black holes' on P439 of *The Emperor's New Mind*[c]. We know from gravitational wave research that some of these black holes ultimately collide, however it may not be necessary for them all to do so.

In the *New Scientist* magazine article 'Entangled Universe', physicists Juan Maldacena and Leonard Susskind describe how, by relating together two areas of Einstein's work in the 1930s, their ongoing research into the Holographic principle has turned up ways in which black holes might be connected. The first is the phenomenon of quantum entanglement. The second is described by the article's author, Anil Ananthaswamy,

> *'It showed how something that looked like two separate black holes from the outside might be connected on the inside. This interior connection formed a shortcut through space-time, and came to be known as an Einstein-Rosen bridge – or in common parlance, a wormhole.'* [d]

Of course, a wormhole connecting two black holes is a far cry from an all-encompassing synapse-like network linking *all* black holes and embodying the completion of the universe's shape – but it at least demonstrates that the idea is feasible. However, since the maths of quantum entanglement is so complex that Maldacena tells us it hasn't yet been worked out in detail, the mathematics of such a network may be, unsurprisingly, as complex as the universe itself.

In such a scenario space may expand and contract all it likes (nothing is nothing however much of it there is) because all expanding and contracting relationships outworking within it are satisfied. *Flatland* presents us with a dimensional structure in which expansion occurs as a simple mathematical phenomenon

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[a] http://www.einstein-online.info/dictionary?search_letter=s&set_language=en#singularity_theorems - Accessed 29th Oct 2015
[b] Roger Penrose, *Cycles of Time*, Vintage 2011, P98
[c] Roger Penrose, *The Emperor's New Mind*, Oxford 1989 (Revised 2016), P439
[d] New Scientist, *Entangled Universe,* Anil Ananthaswamy, 7th Nov 2015

resembling closely the astronomer's expansion wherein galaxies remain at rest relative to the immediate space around them – i.e. space is *viewed by the observer as having increased* because, in the twin demisphere model, there is a continuous increase in the amount of 3D information required to define the increasing separation at *c* between each observer at *Centre B* and corresponding origin at *Centre A*. (Critically, as we will consider in the next chapter, this information is disseminated from *Centre A* at *c*, <u>then</u> redistributed among all *Centre B's* at *c*.)

Reflection… Analogously, like the gap between two unwritten words, a space that separates and defines information has *no intrinsic existence* when isolated from the information it helped define.

Professor Brian Cox describes a time hundreds of billions of years in the future which he refers to as the Degenerate Era when all matter may be inside black holes and the universe suffers heat death. Penrose calls this the *'very boring era'*, and suggests that *'the universe itself, in the remote future, would somehow 'lose track of the scale of time''* [a] [b] [c]

In such a scenario it is not hard to imagine a time counterpart to 'space itself' which also does not exist except to define that which it contains – a kind of ever-expanding 'time itself' which eventually ceases to have any meaning when no observers at no *Centre B's* remain. The universe ends like an 'inverse Swiss cheese' – where the holes are a thing, and the cheese is not.

Confined Truespace

In the Conclusions to their celebrated 1998 paper, Alexei Filippenko and Adam Riess state that,

> *'We also find that the expansion of the Universe is currently accelerating… and that the Universe will expand forever.'* [d]

Within the twin demisphere model an ever-expanding universe is, paradoxically, consistent with the Big Crunch (whether or not it accelerates). We think of the universe as growing bigger because the gaps between things are ever-widening. However if, as we did earlier, we think of *open* space (i.e. 'space itself') as *confined* 3D truespace due to sparsity of information required to define the field, then dimensionally the universe is expanding in terms of *confinedness* whilst matter gathers itself together to pour into the widest open 3-Dimensional spaces of all: black holes. Although we continue to observe the universe as a sphere (because that's how a hypersphere appears in cross-section) what we are actually observing is *all the relationships between everything in which the universe consists* – Einstein's *'four-dimensional continuum'*.

Reflection… The concepts of 'space as confined' or 'truespace as the expression of the 3rd Dimension' are unlikely to make much sense to anyone who has not read up to this point – and perhaps a few who have! They may be found in Section 4, *Dimensional Structure*, and Section 5, *Gravitation as Diffusion*.

Volume of this spherical cross-section (the observable universe) must be reckoned in terms of 'all of 3D, where the 3rd Dimension represents *all the physical information that describes the moment now in the*

[a] Brian Cox, *Wonders of the Universe*, HarperCollins 2011
[b] Roger Penrose, *Cycles of Time*, Vintage 2011, P145
[c] Roger Penrose, *Cycles of Time*, Vintage 2011, P150
[d] http://arxiv.org/pdf/astro-ph/9807008v1.pdf - Accessed 13th Dec 2015

experience of the observer' – rather than our conventional approach to volume which is 'all of 3D including space itself'. (Earlier I referred to this quantity as 'truespace' in order to isolate it as a dimensional concept.) Information 'leaves' the universe just as it entered: having burst forth from the singularity it now crowds back in, with the twin book-ends of the universe – the Big Bang and the myriad black holes – behaving as singularities of inception and completion; dimensionally 'confined' and 'open' singularities, with all things drifting inevitably toward the most relativistically open state.

In this way the hypersphere, or block universe, draws to a close the process of stacking up[a] the 3rd Dimension[b], all in accordance with our Flatland-derived *Principle of Character*[c], and forming an eternal 4D container for the world-lines of every particle that has ever existed within it. Within this container time is of course just another variable, experienced, as Einstein quipped, *'so that everything doesn't happen at once'*.

Interpreting the Analogy

I mentioned earlier that the mathematical success of our *Flatland* analogy rests on the assumption that *Sphere* passes through Flatland at a constant speed. Although not specifically demanded by EA Abbott's storyline this is critical to our deployment of the analogy, corresponding to our observed constant of nature, *c*, the speed of light and gravity. This is the invariant of Relativity which governs ongoing recession between *Centre A* and *Centre B* and therefore the unfolding of the universe. Physicists need not give a reason why *c* is constant, therefore a reason need not be given why *Sphere's* analogous descent is interpreted as constant.

However, because a direct geometrical correlation exists in *Flatland* between expansion/contraction of *Sphere's* slices and the constant recession of their disk-centres from their original point of entry into Flatland (see *Fig.4*), it may be possible by extrapolation into 4-Dimensions to derive from this a mathematical link between *Centre A/B* recession at *c* and the universe's expansion rate through time.

But we must take care not to be too simplistic because, as we have seen, the universe does not subsist within the model as a mere physical 'space' which expands and contracts like a football. The analogised quantity[d] may instead represent the changing rate at which the universe passes from *'initial-type'* to *'final-type'* singularities, or even something else again, such as the rate of proliferation of *Centre B* locations. The reward from a rigorous mathematical treatment of this could be to nail down our universe's future, as its 4-Dimensionality plays out in 3D for the benefit of the observer.

Note that as the following diagram is an extrapolation, the outer circle does *not* represent the observable universe, but the 4D hypersphere of the universe proper. The cross-sectioning line ***xx*** represents the 3D of our observable universe as it passes through the hypersphere (the block universe), whilst the line *AB* describes the progress at *c* of the process of stacking. As suggested above, the disk's changing radius B***x*** may describe either the radius of the observable universe as per the 'extrapolation table' (above), the decelerating/accelerating rate of change of the universe's passage from *'initial-type'* to *'final-type'* singularities, or the increasing/decreasing proliferation of *Centre B's*.

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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] Or perhaps every dimension. In Chapter 47 we will discuss the idea that dimensional stacking may be a concurrent process.

[c] *The Principle of Character:* Once the stacking of a dimension is complete it assumes a whole new character. Its individual cross-sections fuse together and their discrete nature becomes indiscernible.

[d] The accelerating rate of change of radius B*x* (see *Fig.4*).

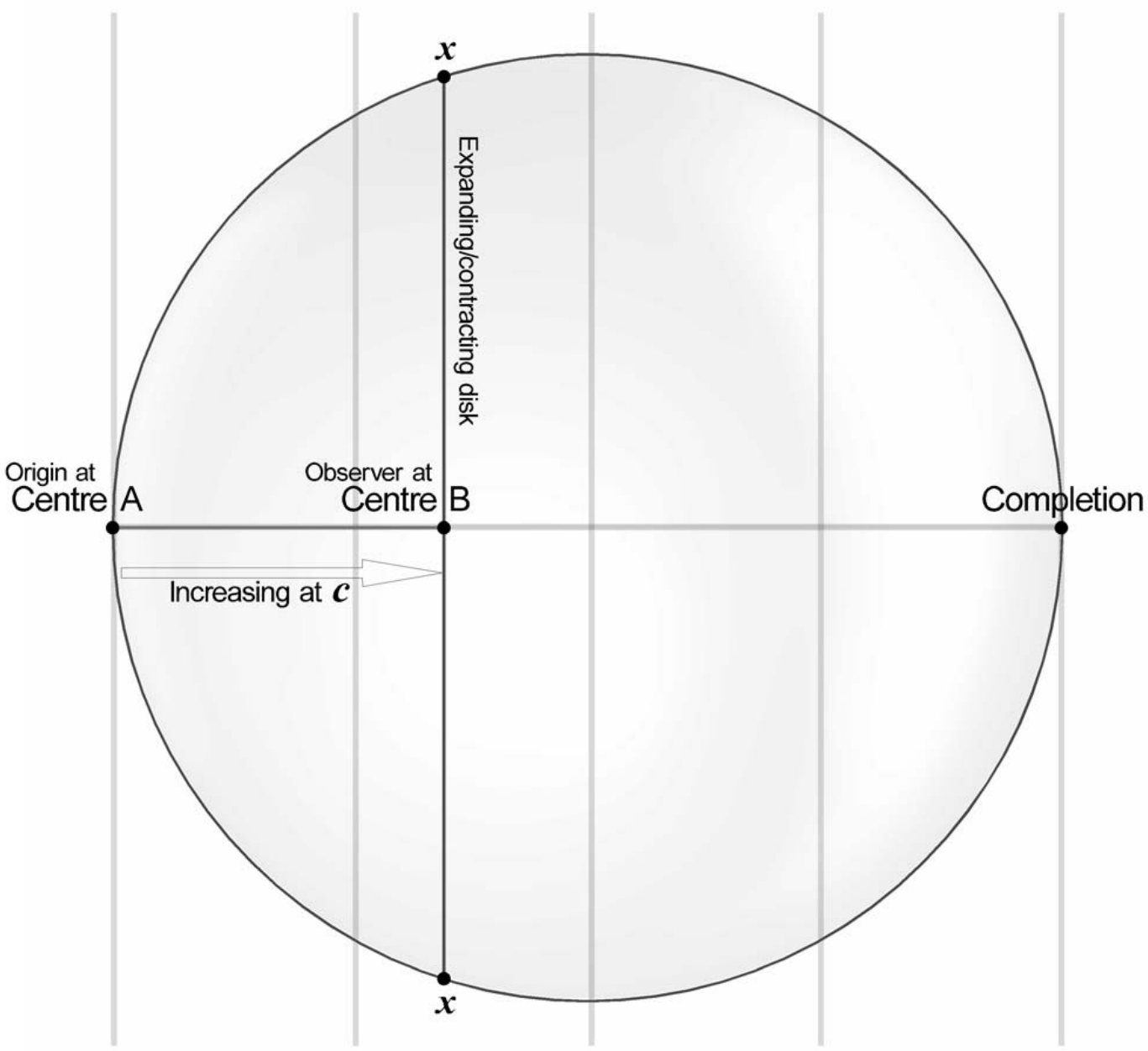

Fig.4 Sphere's analogous passage through Flatland shows how the phenomenon of expansion has two separate but linked aspects: the increasing separation between A and B at the constant *c*, and the increasing/decreasing radius between B and *x*.

The constant recession of *Centre A* from *Centre B* at *c* dictates that the separation between them increases at the rate of 1 light year per year; however, this relationship between origin and observer is expressed in terms of Special Relativity[a]. The expansion/contraction of the universe *as observed* is the result of the fact that light 'whizzes past' us all at *c* whilst we remain at a *Centre B* (see below). Light and the observer are of course both playing by the same rules, as described by Einstein.

Expansion

Within the twin demisphere model, expansion takes place as the outworking of the constant *c* in the 3D cross-sectional experience of the observer. Space itself does indeed expand but, as 'confined 3D'[b], has no inherent significance other than to provide means of expression for the increase in information required to describe the ongoing process (from our viewpoint) of stacking[c] into the 4th Dimension, giving form to all the emergent relationships that comprise the universe – which of course includes the energy of the vacuum[d].

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[a] I.e. it includes variables such as the passage of time for the observer with mass, but not for the photon.

[b] See Chapter 19.

[c] *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.

[d] The vacuum energy is extremely small, as experimentally measured; not extremely large as per 'dark energy' which, in the twin demisphere model, does not exist (again, as experimentally measured). Rather than a mysterious vacuum energy, the model introduces the possibility that our suspicions re dark energy relate to the normal distribution of gravity within the model, which we will look at in Chapter 37.

As described in Chapter 31, the universe's Pac-Man[a] topography rules out the existence of a cosmic horizon beyond which space expands such that objects recede from one another faster than light. Superluminal expansion and infinity are both ruled out absolutely by the model because:

- The phenomenon of expansion itself is simply the physical outworking (in our experience of SR) of the ever-increasing distance that light is viewed by the observer as having travelled throughout the cosmos between origin and observer.

This necessarily increases the radius of the view (see *Fig.5*, below). In other words, the observer[b] is the constant spectator of a universe in which light is observed to have travelled farther, and, since the origin must always lie on our observable universe's surface (*Centre A*, projected) with the observer at the centre (*Centre B*), all observed distances within the observable sphere increase smoothly to compensate like a puff of relativistic smoke.

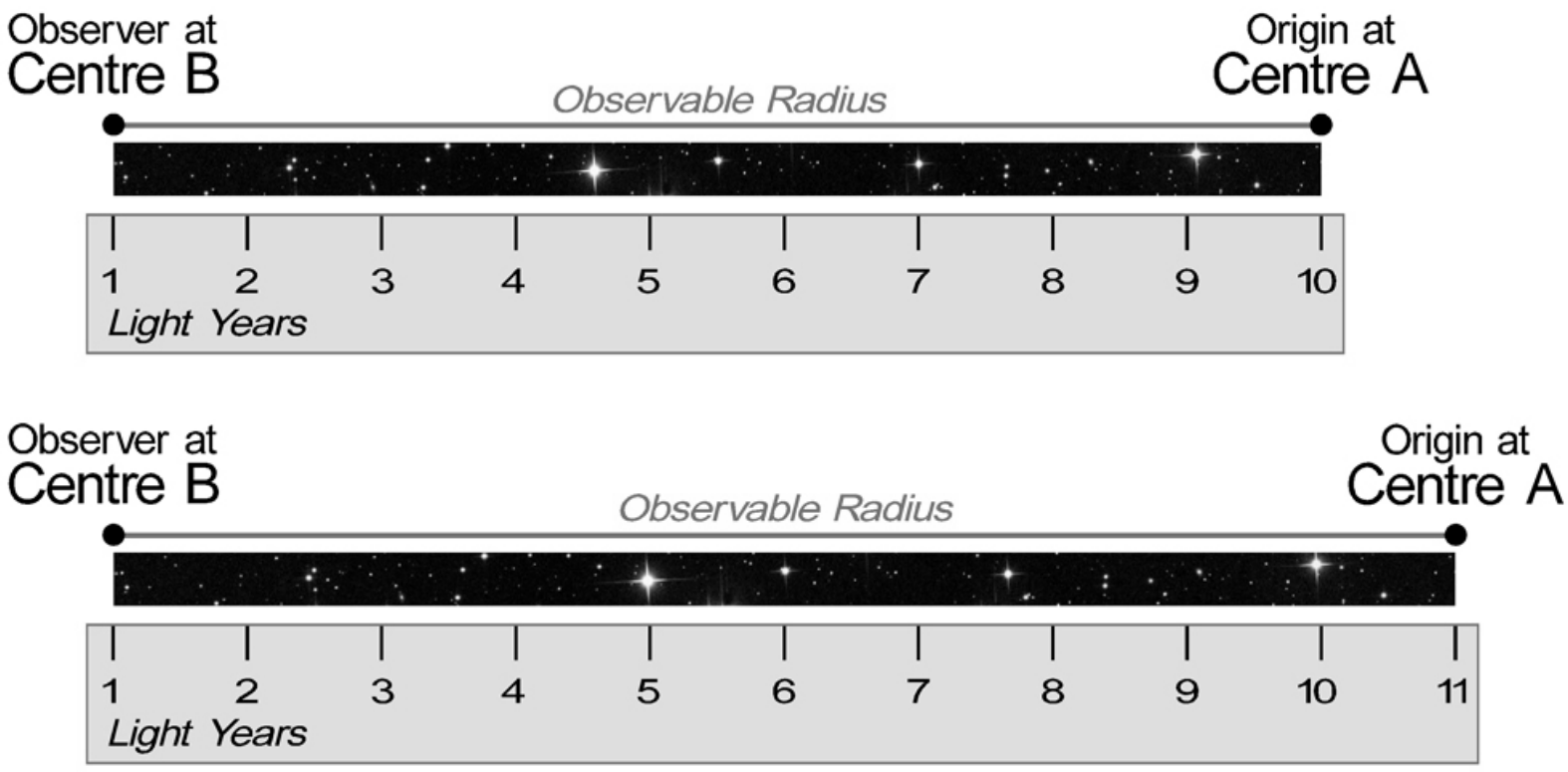

Fig.5 For the purpose of illustration let's imagine the universe is 11 years old. A year ago it was 10 years old but light has been travelling for another year. As a result, relic radiation is 1 year older and the observer looks out on a universe whose observable radius has expanded (in look-back distance) by one light year. Because the universe is observer-centric this experience is repeated at every point in space as a *Centre B*, and all objects are now spread evenly through a radius of 11, rather than 10, light years.

Please note that this is not a purely 'physically generated' expansion of space caused by a mysterious energy no-one can find which somehow 'makes it expand', but the result of the relativistic transfer of information in keeping with Special Relativity which defines the *Centre A/Centre B* relationship of every space-time event[c] (see Chapter 33). For example, the stationary observer will experience her own *Centre*

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[a] *The Pac-Man Principle:* As viewed by an observer, the path of light is always along a section of the 3D longitudinal geodesic between the origin at *Centre A* of the northern demisphere and the observer at *Centre B* of the southern demisphere.

[b] As my son commented the other day, the key to the (twin demisphere) model is always to remember that it is observer-centric.

[c] The equal significance at each point-event of this relativistic expansion means that the past and present universe are co-existent in the 4th Dimension. Time is a purely cross-sectional phenomenon (described by the *Magic Treadmill Principle* in Chapter 11) due to the observer's existence as the 'axis' through which reality unfolds. More on this in Section 7 when we come to investigate the place of life within the dimensional structure.

A/B recession at *c* as the passage of time, but her universe will still have expanded by one light year, because – also in obedience to SR – light and gravitational information always propagate at *c*.

We will examine the knock-on effect of this on *Centre B/Centre B* relationships in the next chapter. As we are about to consider, this scenario could turn on its head the Standard Model's assertion that gravity holds sway over expansion, because the model indicates it may be the other way round.

The Speed of Light

One of the ways it might help us to shift our thinking on all this would be to stop thinking of the photon as 'travelling through the universe at the speed of light'. It's like saying 'Christopher Columbus discovered America'. No, he didn't. There were people there already. In exactly the same way we tend to think of and describe our relativistic universe from the prejudicial standpoint of only one kind of observer: us. In reality, we and the photon are all sojourners through a common experience of the universe which Einstein began to describe in 1905.

The photon sits within its *Centre B*, as do we. It experiences no movement because its universe is length contracted to zero. Sitting on the cusp of *Centre A*, separated only by its obedience to SR, it has experienced no movement and yet it finds itself 'as expanded' as the universe. We view it moving at *c* because *the observable universe* is unfolding at the invariant *c*, as are we. Indeed, it is probably fair to say that the 3rd Dimension is stacking relativistically into the 4th at the constant *c*.