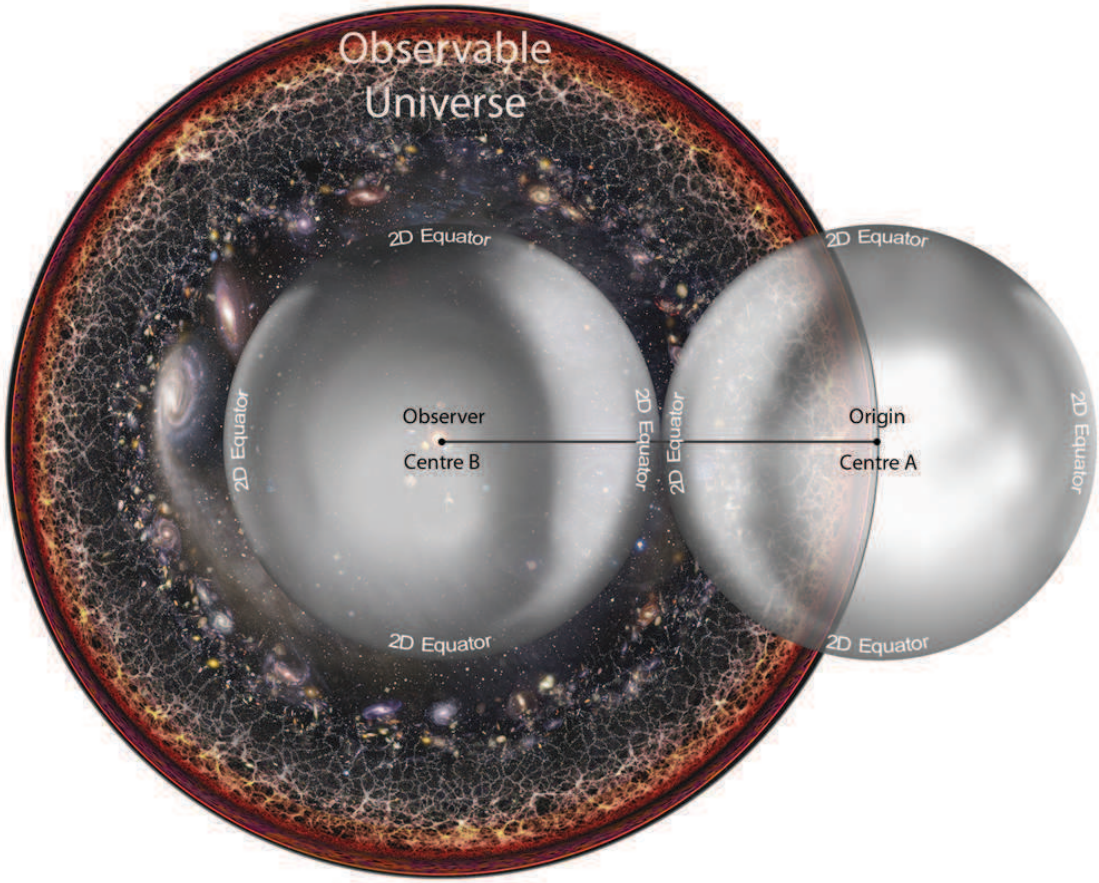
A Series of 15 Essays Relating to the Spatial/Temporal Distinction, and the Cosmological Shape and Observer-Centric Characteristics of the 4D Global/3D Observable Universe

William JE Brown

Abstract

Although mathematically basic, the geometrical principles enshrined within Edwin Abbott Abbott's 1884 work, Flatland: A Romance of Many Dimensions are unyieldingly consistent, and although Albert Einstein did not directly credit EA Abbott in Part III of his 1916 popular work Relativity, he deployed the little Flatlanders to great effect assuring us that 'the three-dimensional spherical space is quite analogous to the two-dimensional spherical surface'. In this series of 15 concise scientific essays we will follow through on the simplicity and consistency of Abbott's approach. Deriving from Flatland a set of named principles [Appendix 1] which are held to be true of the geometrical relationships between (n-1)D, nD, and (n+1)D, these are brought to bear on the contemporary scientific paradigm with the aim of exploring the potential for a consistent dimensional structure for the whole of nature. Flatland extrapolation through 1/2/3/4D reveals the action of the temporal dimension to be a product of the dimensional viewpoint of the observer; time is therefore not intrinsic to the 4th Dimension. The dimensional structure thus derived exists as a fundamental framework for all of nature, of which combinations of length, width, depth, and time merely exhibit properties. Within this structure the universe emerges at the level of the 3rd Dimension (observable) and 4th Dimension (global), adhering strictly to Flatland principles applied spherically throughout. The model described is the finite 3-sphere of Einstein, with the crucial difference that observer and origin are located at antipodal centres (poles) of the 3-hemispheres, rendering the whole 'observer-centric'. Without altering constants, GR, or QM, the model solves the horizon problem of CMB uniformity, explains the 1998 distant SNe Ia light anomaly, shows the universe to have net zero gravity (explaining so-called dark energy), reveals the correct mechanism behind expansion, shows in terms of information transfer why both gravity and light exist at c, describes the mechanism by which the universe diminishes to a Big Bang singularity, and provides a theoretical basis for the Equivalence principle. In the process it dispenses with infinity, superluminality, Cosmic Inflation, the G/DE knife-edge, recent acceleration, and the cosmological constant.



The Observer-Centric Universe

[a] Abridged from Sections 2, 5, and 6 of *A Dimensional Structure for Reality*: https://www.amazon.co.uk/dp/197390795X

15 Essays

summarising the central arguments relating to
the spatial/temporal distinction, and the cosmological shape and
observer-centric characteristics of the 4D global/3D observable universe

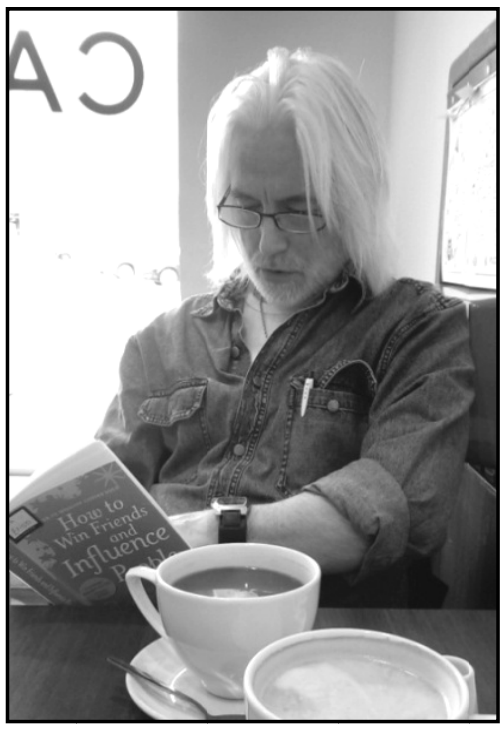
William JE Brown

An exploration of the dimensional principles of
EA Abbott's 1884 classic 'FLATLAND'

"Very consistent."

Dr Charles Wang, theoretical physicist, University of Aberdeen, Scotland

About the author…



Born in Edinburgh in 1957 my childhood was filled with reading, an early romance with Palaeontology and Astronomy culminating in the study of Maths and Physics at the University of Aberdeen (sadly not completed) and a career in computing and design.

In March 2012, I was struck quite suddenly by the (commonly recognised) idea of the 4th Dimension as a stacking-up of 3D snapshots of the 'moment now'. By a process of extensive reading, research, and intensive thinking this developed into the wholly original dimensional structure as abridged[a] within these 15 essays, based firmly on the straightforward geometrical principles of EA Abbott's 1884 classic,

Flatland: A Romance of Many Dimensions.

Regarding the application of *Flatland*-derived principles to the world...

Paul Davies:

> *'...the laws of physics stand at the base of a rational explanatory chain, in the same way that the axioms of Euclid stand at the base of the logical scheme we call geometry. Of course, one cannot prove that the laws of physics have to be the starting point of an explanatory scheme, but any attempt to explain the world rationally has to have some starting point, and for most scientists the laws of physics seem a very satisfactory one. In the same way, one need not accept Euclid's axioms as the starting point of geometry; a set of theorems like Pythagoras's would do equally well. But the purpose of science (and mathematics) is to explain the world in as simple and economic a fashion as possible, and Euclid's axioms and the laws of physics are attempts to do just that.'* [b]

Marcelo Gleiser:

> *'...any new theory attempting to extrapolate beyond tested ground should, in the proper limit, reproduce current knowledge.'* [c]

Carlo Rovelli:

> *'Einstein frequently maintained that the experiments of Michelson and Morley were of no importance in allowing him to arrive at special relativity. I believe this to be true, and that it illustrates an important factor in the philosophy of science. In order to make advances in our understanding of the world, it is not always necessary to have new data.'* [d]

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[a] From the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X
[b] Paul Davies, *The day time began*, from the *New Scientist* collection: *Nothing*, Profile Books 2013, P54
[c] Marcelo Gleiser, The Island of Knowledge, P xix
[d] Carlo Rovelli, *The Order of Time*, Penguin 2017, P189

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First uploaded to Amazon **create**space: 25th May 2018
First Edition uploaded to Amazon **create**space: 18th July 2018
Second Edition uploaded to Amazon **KDP**: 12th February 2019

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15 Essays abridged from:

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First uploaded to Amazon **create**space: 25th July 2017

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www.dimensionalstructure.com

ISBN-13: 978-1720908692
ISBN-10: 1720908699

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A Series of 15 Essays

summarising the central arguments relating to
the spatial/temporal distinction, and the cosmological shape and
observer-centric characteristics of the 4D global/3D observable universe, from the book:

A DIMENSIONAL STRUCTURE FOR REALITY[a]

by *William JE Brown,* Aberchirder, Scotland, 25th July 2017

(*An application and extrapolation of principles derived from:*
FLATLAND: A Romance of Many Dimensions *by* Edwin Abbott Abbott, 1884)

Contents:

[a] Abridged from Sections 2, 5, and 6 of *A Dimensional Structure for Reality*: https://www.amazon.co.uk/dp/197390795X

Introduction:

My aim in this series of brief essays is to abridge for the specialist the main ideas from the book relating to physics and cosmology. Although not adhering strictly to the structure of the scientific paper, they are written in the same direct style, assuming prior knowledge of EA Abbott's *Flatland*.

The geometrical principles enshrined within Edwin Abbott Abbott's 1884 work, *Flatland: A Romance of Many Dimensions* are straightforward and consistent, and although Albert Einstein did not directly credit EA Abbott in Part III of his 1916 (popular) work *Relativity*, he deployed the little Flatlanders to great effect assuring us that *'the three-dimensional spherical space is quite analogous to the two-dimensional spherical surface"*[a]. In this series of 15 concise scientific essays we will follow through on the simplicity and consistency of Abbott's approach.

Deriving from *Flatland* a set of named principles which are held to be true of the geometrical relationships between (*n*-1)D, *n*D, and (*n*+1)D [listed in *Appendix 1*], these are brought to bear on the contemporary scientific paradigm with the aim of exploring the potential for a consistent dimensional structure for the whole of nature. *Flatland* extrapolation through 1/2/3/4D reveals the action of the temporal dimension to be a product of the dimensional viewpoint of the observer; time is therefore not intrinsic to the 4th Dimension. The dimensional structure thus derived exists as a fundamental framework for all of nature, of which combinations of length, width, depth, and time merely exhibit properties.

Within this structure the universe emerges at the level of the 3rd Dimension (observable) and 4th Dimension (global), adhering strictly to *Flatland* principles applied spherically throughout[b]. This model of the observable universe[c] is the finite 3-sphere of Einstein, with the crucial difference that observer and origin are located at antipodal centres (poles) of the 3-hemispheres, rendering the whole 'observer-centric'.

Without altering constants, GR, or QM, the model solves the horizon problem of CMB uniformity, explains the 1998 distant SNe Ia light anomaly, shows the universe to have net zero gravity (explaining so-called dark energy), reveals the correct mechanism behind expansion, shows in terms of information transfer why both gravity and light exist at *c*, describes the mechanism by which the universe diminishes to a Big Bang singularity, and provides a theoretical basis for the Equivalence principle. In the process it dispenses with infinity, superluminality, Cosmic Inflation, the G/DE knife-edge, recent acceleration, and the cosmological constant.

Note: Please do not be distracted by my use of Abbott's names, *A Square*, *Sphere* etc; these are used to denote the observer's location at a single spacetime event. Also, each dimensional world is treated as a spacetime; e.g. Flatland is not a flat surface in the usual 2D sense, but one spatial and one temporal.

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[a] Albert Einstein, *Relativity, Appendix 5*, Routledge 2001, P151. Note that Einstein's (translator's) use of the word 'quite' would be in the old sense of 'exactly', rather than the modern sense of 'roughly'. I suspect that rough analogies would have been of little use to him.

[b] *'...of all closed surfaces, the sphere is unique in possessing the property that all points on it are equivalent.'*Albert Einstein, *Relativity* (1916), Routledge 2001

[c] Termed the 'observer-centric model'.

"Truth is ever to be found in simplicity,
and not in the multiplicity and confusion of things."

Isaac Newton

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 1/15:

The spatial/temporal distinction is not intrinsic to the dimensional structure itself, but results from the dimensional viewpoint of the observer within a universal structure

Abstract

By extrapolating the perception of theoretical 1-Dimensional, 2-Dimensional, and 3-Dimensional beings the application of *Flatland*-derived principles demonstrates that our spatial/temporal distinction is not inherent within the dimensional structure itself, but is instead produced by the dimensional location and viewpoint of the observer. Consequently the dimensions in our 4-Dimensional universe may be intrinsically neither 'spatial' nor 'temporal'. Observer-based sphericality applies throughout, revealing the 4-ball 'shape' of the global universe and the 3-sphere shape of the observable universe.

Viewpoints

How we see things can depend where we're looking from – our vantage point. Without the benefit of satellite imaging, for example, how should we have discovered the full extent of the caldera that is Yellowstone National Park? Taking as our starting point the axiomatic idea that there exist three spatial dimensions and one temporal dimension[b] we must remember that if a dimensional structure exists we are all living inside it. English mathematician Sir Roger Penrose writes: *'Whatever it is that controls or describes the mind must indeed be an integral part of the same grand scheme which governs, also, all the* ***material*** *attributes of our universe.'*[c] [Emphasis his] Not only are we in it, but it is in us, and there is no aspect of human experience that could be said to lie outside it[d].

As a result, in our efforts to visualise the dimensional structure's shape we can never have the luxury of viewing it from the outside. In addition, the *Flatland*-derived *Principle of Extension*[e] combined with the *Principle of Stacking*[f] [listed in *Appendix 1*] renders each successive dimension vastly more complex than the last. There are therefore only three vantage points from which the observer might attempt to view any dimension within a consistent *Flatland*-based dimensional structure: from above, level, or below, as expressed within the *Principle of Viewpoints*[g]. We will briefly consider each in turn. Although much of this may seem like stating the obvious, my purpose here is to show two things about the role of viewpoints as they relate to our perception:

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[a] This essay was abridged from Chapter 8, *Viewpoints*, and Chapter 9, *Finite and Edgeless*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] A number of 'extra' spatial dimensions are hypothesised within String theory but these are not only inconsistent with a *Flatland*-style structure, but empirically unconfirmed.

[c] Roger Penrose, *Shadows of the Mind*, Vintage Books 2005, P213

[d] With the single possible exception of a transcendent God.

[e] *The Principle of Extension:* Each dimension is an extension in a new direction of the one below.

[f] *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.

[g] *The Principle of Viewpoints:* Any dimension may be viewed from three vantage points: from above (complete), level ('edge-on'), or below (in cross-section).

1) Largely taken for granted, viewpoints extend virtually unnoticed into all aspects of life, and
2) Our everyday experience of viewpoints obeys the same rules in principle as EA Abbott demonstrated apply between geometrical dimensions.

From above

Sphere could see Flatland in all its 2D glory. As in our own world, looking down from above is always the best vantage point from which to take in any situation. Here are a few everyday examples of this principle in action:

- *Snooker.* Players assess the position of the balls from above before taking their eye-level shot.
- *A debate.* The audience must weigh up the intellectual credibility of the arguments presented, gaining an overview before arriving at a decision.
- *A courtroom.* Emotions run high, but it is the Judge's job to remain above them. He/she must retain an impartial viewpoint to give justice a chance.

Not all these examples are of a *physical* bird's eye view. They include the emotional, the intellectual, and the moral. Of course we might consider the debate or the Judge to be overviews in metaphor only, however, if a *Flatland*-style dimensional structure permeates reality, we should not be surprised to find that everything within it obeys *Flatland* geometrical principles.

On the level

This is not so easy. Edwin Abbott Abbott had to equip *A Square* with all manner of a-geometrical superfluity (such as fog and shiny edges) to help him cope with his world. Although Flatland is 2D, *A Square's* viewpoint reduces it to an edge-on 1D circle around him. Viewing anything at ground level restricts the amount of information we can access. Examples of this are harder to find because no-one ever chooses eye-level over aerial and normally we would have to be restricted by the situation, as in the case of:

- *Tennis*. If you've ever played the game your respect for the professionals will probably have increased. Not only is the court about five times the size it looks on TV, but it's almost impossible to see over the net!
- *Ancient maps*. The first cartographers produced incredible work in difficult circumstances; maps which represent humankind's earliest efforts to piece together a theoretically aerial view of an exclusively ground-level world.

From below

Unless you are an astronomer there is usually little advantage to looking up. As *Flatland* shows, viewing dimensionally from below – as per *A Square's* doomed efforts to work out where *Sphere's* voice was coming from – there is nothing to see, because a 2-Dimensional surface has no 3rd Dimension of height. The higher dimension is therefore completely invisible to the lower and we must permit this simple geometry to inform our worldview. As *Flatland* demonstrates, a lower dimension may only experience a higher in cross-

section. However, paradoxically, although the part of *Sphere* that the Flatlander witnessed was a disk (a 'Circle'), this 2D slice bore the full characteristics of 3D *Sphere*. There is a complex interplay going on at the place where dimensions meet and intersect.

Finite and edgeless

There are many ways to engage with the subject of dimensions and computer-aided geometrical shapes is one of them. However my purpose here is to delve into what Thomas F Banchoff, Professor of Mathematics at Brown University and a leading expert on *Flatland*, calls the *'method of analogy'*[a], and to use it to pry not just into geometry, as is the custom, but perception. To do this we must ask, *'What would it be like, actually living in a world of less dimensions than the one we are in?'*

Flatland is a frequently referenced book[b], although most writers don't go into detail, accepting at face value that 3-Dimensional *Sphere* who dwells in Spaceland represents us and the universe in which we live. This is understandable as Abbott himself has written him this way: for example in Chapter 16 of *Flatland* where he addresses us as *'Every reader in Spaceland'*. However, to her credit the character 'Vikki' from mathematician Ian Stewart's wide-ranging 2003 tribute *Flatterland* is not taken in, as she talks to her Diary about *'the days when [A Square] visited what he was TOLD was Spaceland'* and gets exasperated that *'[humans] keep changing their minds about which Space they are actually in.'*[c]

Several decades after *Flatland* Albert Einstein showed that we do not inhabit a simple 3D space, but a 4D spacetime. This means that in order to apply *Flatland* analogies accurately we must get to grips with the temporal dimension, but this is not beyond analogy since, mathematically, a spacetime may comprise any number of dimensions. Let's begin by taking a closer look at the Flatlander's viewpoint.

The Flatlander's perception

A Square dwells in Flatland. Within our minds we cast him as an imaginary 2-Dimensional being, immersed in the all-consuming flatness of his 2-Dimensional world. However, although his world is flat, that is not how he sees it. *A Square* views his world edge-on, 'level with the page' as it were (by the *'Edge-On' Principle*[d]). Gazing out through his hypothetical 2D eyes he views a line, which is 1D. From his viewpoint, all he sees as he turns to look around him is a continuous line which describes a 360° circle. *A Square* lives in a 2D world but he views his entire universe in 1D. The circle it describes around him appears to him *infinite*, because a circle has no beginning and no end; however a circle is also a *finite* entity because it loops back on itself. The geometry of a circle possesses both properties simultaneously, therefore:

In one single defining statement we can say that the Flatlander is…

- hemmed in by a continuous circle of
  confining 1-Dimensionality with no beginning and no end.

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[a] http://www.math.brown.edu/~banchoff/gc/ISR/ISR.html - Accessed 19th March 2016
[b] E.g. by Sagan, Hawking, Kaku, Penrose, Levin, Tegmark.
[c] Ian Stewart, *Flatterland*, Pan Books 2003, P188
[d] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.

As *A Square* reaches out to touch his world he also feels it edge-on. Everything he experiences by the senses comes at him edge-on and wherever he looks he sees a line. Like a little *Playstation* footballer, whenever he moves in his flat world his 1D circle moves with him, and he is always at the centre, looking out, sensing out. And because his experience of the circle is immediate, it cannot be thought of as existing at a certain distance from him or possessing a variable radius. The absence of depth from his experience means that his physical environment exists at *no extended distance* from him. His circle-experience is 'jammed up against him', integrated into his perception. Nonetheless, for Flatlander, the 1D edge of his circle is very real because, in his world, it constitutes his experience of space[a].

But what if our Flatlander lives on the equivalent of a chess-board, arrives at the edge, and falls off? Fortunately for *A Square*, following on from the fact that he is hemmed in by a circle this option proves mathematically impossible. This will become clear as we go.

The Spacelander's perception

At this point we will apply one of our *Flatland*-derived principles:

> *The Principle of Relationship:*
> **Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.**

This encapsulates one of *Flatland's* core concepts, enforcing consistency throughout the structure. Everything that happens to *A Square* also happens to *Sphere*, one dimension up, therefore, just as:

- *Square* looks out from within his 2D world and sees edge-on in 1D, so
- *Sphere* looks out from within his 3D world and sees 'flat-on' in 2D.

Sphere views his world in 'flatscreen'. He lives in a 3-Dimensional universe but his viewpoint is 2-Dimensional, possessing only length and width. This is the *'Edge-On' Principle*[b] in action, one dimension up. Lacking depth of field, *Sphere's* world is viewed by him like a 2D film. It's hard for us to imagine how *Sphere* looks out at his 3D world and views it 'edge-on' in 2D flatscreen because all our screens exist at an extended distance from us. Not so with *Sphere*. Just as *Square's* encompassing circle was at zero distance from his perception, so it is with *Sphere's* spherically encompassing flatness which is in a sense 'shrink-wrapped' around him. The reason is the same: neither of them possess visual depth. Mathematically he views the 2-sphere surface of a 3-ball. As observer, he experiences his world from its centre[c]. In this way his universe-experience is 'observer-centric'. *Sphere* is experiencing the 2D analogue of *A Square's* confining 1-sphere circle, and, recalling how *A Square* was able to touch objects edge-on, in the same way

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[a] In Chapter 17 of *Flatland*, EA Abbott has *Sphere* inform *A Square*, *"What you call Space is really nothing but a great Plane."* However, as we shall see, the Flatlander may be considered to inhabit a 2D spacetime in which his 2nd Dimension acts as his means of change. This critical distinction was unknown to Abbott's pre-Einsteinian world.

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

[c] Although he views this 2-sphere surface from its centre, the surface has no 'inner' or 'outer' because, being 2-Dimensional, it has no thickness.

Sphere feels the hypothetical 2D surface of 'flat things' all around him. This flat surface forms the spherical boundary for all his sensory experience.

This is not at all easy for us to picture because it is not a situation that occurs in nature. *Sphere's* experience of 3D Spaceland means that he is 'vacuum-packed' by the *'Edge-On' Principle*[a] into a spherical yet depth-free world that is integrated into his perception, constituting his 2-Dimensional experience of space.

We observed above that *A Square* looked out and saw himself…

- hemmed in by a continuous circle of
  confining 1-Dimensionality with no beginning and no end.

In the same way *Sphere* is…

- hemmed in by a flatscreen sphere of
  confining 2-Dimensionality with no beginning and no end.

The 2D Flatlander is surrounded by a 1D circle whilst the 3D Spacelander is surrounded by a 2D spherical surface. This flatscreen 2-sphere upon which he is able to 'look down' always from the zenith, and which forms the finite but edgeless boundary of 3D Spaceland, is therefore Flatland[b]. Flatland is a sphere, which is why – as mentioned above – *A Square* can't fall off. In keeping with the *'Edge-On' Principle*[c], Flatland is the 3D Spacelander's 2D field of vision.

The Linelander's perception

This scenario also holds good down the way. The *King of Lineland* who lives one dimension down from Flatland inhabits the endless 1D loop of *A Square's* confining circle. Lineland is *A Square's* field of vision. When the *King*, as a hypothetical 1D being, looks out both ends of his little liney body through his (conveniently located) eyes, he sees two points, one above his head and one beneath his feet – like viewing a needle point-on. This is his full sensory experience of his world both ways along his circle, and since a point is a 0-Dimensional entity, these twin (0-sphere) points would be completely invisible to him. If we accept *A Square's* dimensional perceptions, in geometrical principle we must acknowledge these as also the case for the *King of Lineland* (one dimension down) and *Sphere* (one dimension up) as summarised within the *Principle of Relationship*[d] which describes the the consistency of a *Flatland*-based dimensional structure.

The Hyperlander's perception

I would now like to introduce a mythical dweller in a place I shall call Hyperland: a 4-Dimensional being who dwells one dimension up from *Sphere's* Spaceland, and two dimensions up from Flatland, whom we

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

[b] The sphericality of the Flatland scenario was explicated by the Dutch mathematician Dionys Burger in his 1965 *Flatland* update, *Sphereland*, Harper & Row 1983, written with all new characters in the same style as the original. Burger adjusts the tale's geometry in the light of Einstein's Relativity – which was still two to three decades away when *Flatland* was written – to include the key elements of curvature and expansion.

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

[d] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

shall call *Abbott.* *Abbott* inhabits a 4D universe. However, exactly like the previous characters in dimensions below, he does not actually view his world in 4D, but – again by the *'Edge-On' Principle*[a] – one dimension lower. *Abbott* experiences his environment in 3D; all around *Abbott*, the world he sees and touches is 3-Dimensional, possessing length, width and depth.

Just as *A Square* looked out and saw himself…

- hemmed in by a continuous circle of
  confining 1-Dimensionality with no beginning and no end,

and *Sphere* was…

- hemmed in by a flatscreen sphere of
  confining 2-Dimensionality with no beginning and no end,

even so, *Abbott* is…

- hemmed in by a depth-of-field sphere of
  confining 3-Dimensionality with no beginning and no end.

Abbott inhabits our world: the physical universe in which we live. Although we live in a universe of 4-Dimensions, the world as we actually view it is 3D, and it is 3-Dimensional to the touch – of these simple observations there can be no doubt. This is the expression of the *'Edge-On' Principle*[b] which applies in the real world precisely as it applies in Flatland. The 3D that we see, which we call space, is the confining boundary of our 4D universe which – just like *Sphere, A Square* and the *King of Lineland* – we experience one dimension lower. In other words, ***Flatland tells us why the world around us is 3-Dimensional***. It is because the universe is 4D that we experience the world in 3D.

Space and time

Our 4D spacetime comprises three dimensions of space and one of time. Although we can neither see nor touch time we are continually aware that it is there, marching on relentlessly to complete our 4-Dimensional experience. In our world our invisible 'last' dimension we call time because it acts as our 'means of change', constantly refreshing 3D scenarios. Therefore, by applying the *Principle of Relationship*[c] we now know that the invisible last dimension in Spaceland, Flatland and Lineland must also act as the temporal dimension to each of their worlds[d]. Cosmologist Janna Levin writes, *'As much as we try to make time the same as space, it still seems different."*[e] The principles of *Flatland* demonstrate that time's difference from the 'spatial' dimensions is not intrinsic to time. It is the product of the observer's dimensional viewpoint – i.e. our location within the dimensional structure – and is not inherent within the *nature* of the 4th Dimension, as currently supposed. Were we somehow able to step outside our level and view the

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[a] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.
[b] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.
[c] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.
[d] See Essay 2
[e] Janna Levin, *How the Universe Got Its Spots*, Phoenix 2003

dimensional structure from a 5th Dimension or higher, what we experience as time would be seen to behave spatially.

Deceived by depth

We tend to think of space and 3D as the same thing. However, that is just how we 4D dwellers happen to experience it. To be space an environment does not require depth; only '3D space' requires depth.

- Our space is 3D and our spacetime is 4D
- The Spacelander's space is 2D and his spacetime is 3D
- The Flatlander's space is 1D and his spacetime is 2D

We saw above how *Sphere* and *Square's* environments are integrated into their perception, so by the *Principle of Relationship*[a] this is equally true for us. *3-Dimensionality exists at zero extended distance from us* as we look lengthwise, widthwise and depthwise all around, from and into our universe. On its own, depth as we perceive it has nothing whatsoever to do with the shape or location of boundaries within our universe. 3D is 'jammed against our perception' and we are wholly integrated into it.

Flatland geometry reveals to us that our universe has a 3-Dimensional boundary, but it is 3-Dimensionality *itself* that forms the boundary, which is everywhere and everything our senses experience. And like the Spacelander's 2-sphere surface of a 3-ball, but up by one dimension, the 3-sphere surface of our universe is finite yet unbounded. Analogically it is *we* who see Spaceland, because we inhabit Hyperland. For ease of reference let's put it all together in a grid:

World	*Character*	*How they sense*	*D's sensed*	*D's experienced*
1D Lineland	*The King*	Point-on	0D	1D
2D Flatland	*A Square*	Edge-on	1D	2D
3D Spaceland	*Sphere*	Flat-on	2D	3D
4D Hyperland	*Abbott*	3D-on	3D	4D

The shape of the universe

Now, because we are able to extrapolate up from Flatland's 1-sphere/2-ball through Spaceland's 2-sphere/3-ball to Hyperland's 3-sphere/4-ball, the process tells us the shape of our universe. Much cosmological speculation is answered by the simple logic of EA Abbott's *Flatland* which demonstrates that:

- **The observable universe is geometrically equivalent to a 3-sphere**[b]
- **The global universe is geometrically equivalent to a 4-ball**[c]

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[a] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

[b] Note that the observable universe further breaks down into north and south hemi-balls (or 3-hemispheres), linked by their 2-Dimensional equator. See Essay 5

[c] Commonly referred to as a hypersphere.

Or rather, the process *confirms* to us the shape of the universe[a], because – although infinite models are perhaps currently preferred – there is nothing scientifically new in the idea of a finite universe based on sphericality or the global universe as a 'hypersphere'. Indeed there is something of orthodoxy in this view; in Part III of his popular description of Relativity, Albert Einstein wrote in 1916 that, *'It follows from what has been said, that closed spaces without limits are conceivable. From amongst these, the spherical space (and the elliptical) excels in simplicity, since all points on it are equivalent.'*[b] But how wonderful it is to see that it was there all along, decades before Relativity, nestled within the unerringly consistent principles of Edwin Abbott Abbott.

Shape itself as representation

Science writer John Gribbin tells us that scientific models *'should always be regarded as approximations and aids to the imagination, rather than the ultimate truth.'*[c] Our Earth-bound concept of 'shape' is inadequate when applied to the universe, misleading us into the false association of 'depth' with 'space'. (As described above, this is phenomenological within a 4D universe and there can be no generalised relation between these two.) Although the geometrical principles are the same for the circle and the sphere, the inference is not that the Flatlander and the Spacelander's confinements 'are' those shapes, but that they represent the theoretical experience of space, integral to their perception, that defines their environment. Of course we need the concept of shape or we couldn't think or do maths, but the thing to notice is that we indwell a consistent *Flatland*-style, observer-centric dimensional structure, and the 3-sphere/4-ball acts as a useful and accurate geometrical analogy which at the 3/4D level describes our universe, but which may be extrapolated to apply between all dimensions[d] in keeping with the *Principle of Relationship*[e].

Conclusion

Significantly, what all this demonstrates is that our 4th Dimension is not as *Wikipedia* and much of the scientific world would have it *'of a different sort from the spatial dimensions'*[f], because they are all exactly the same. 4D may appear *to us* to behave differently but it is not of a different sort. There is therefore no need for physicists to '*make time the same as space*', because it is already. Our experience of the 4th Dimension as 'temporal' is the product of the observer's dimensional viewpoint within a structure, whilst all dimensions in the dimensional structure behave consistently in accordance with the straightforward principles of EA Abbott's *Flatland*.

If time is therefore not *intrinsic* to the 4th Dimension, this carries the implication that all dimensions within such a structure are likely to be inherently neither 'spatial' nor 'temporal', with the whole instead existing at a fundamental level as a 'continuum', 'container', or 'framework' for the natural realm, within which the *geometrical properties and interplay between points, lines, planes etc* apply with consistency.

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[a] This conclusion could have been derived from *Flatland* in 1884.
[b] Albert Einstein, *Relativity, Section 31*, Routledge 2001, P114
[c] John Gribbin, *The Universe: A Biography*, Penguin Science 2008, P2
[d] Up as well as down.
[e] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.
[f] https://en.wikipedia.org/wiki/Spacetime - Accessed 29th Dec 2012

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 2/15:

The 'magic treadmill of time': a description of the operation of the means of change

Abstract

Again by extrapolation of the perception of theoretical 1D, 2D, and 3D beings, a mechanism emerges which expresses the way in which the *n*th (last) Dimension within an *n*D spacetime is always experienced as the means of change, emanating from every spacetime event in (*n*-1)D space to form the receding past, demonstrating how the 'block universe' exists as a recurrent dimensional feature within the structure. The magic treadmill also explains the invisibility of the last dimension, and a discussion ensues on the relationship of the 'arrow of time' to stacking. Thus, with all dimensions rendered consistent in their obedience to the principles of *Flatland*, the groundwork is laid for the application of a logically and geometrically consistent dimensional framework to the whole of reality.

The role of the observer

There exists considerable evidence[b] that space and time share a common origin at the Big Bang, and as the unified entity spacetime they are inexorably linked, but time is the problem child of physics and continues to defy all efforts at restraint. However, as concluded in Essay 1, there is nothing in the logic of Dimensionality[c] to suggest that the 4th Dimension is in any way, as described in *Wikipedia*, *'of a different sort from the spatial dimensions'*[d]. So what is it that makes time seem different? Is it…

a) Time's 'non-spatial' invisibility? Or…
b) Time's one-way arrow?

Yes to both. So now we must ask: *How is it that the last dimension in our 4D universe seems to glide unseen from the past into the future?* To answer this we will *not* take these anomalies as our starting point, because to focus on them may lead us up back alleys of arbitrary reasoning. Instead, because *Flatland* demonstrates such elegant consistency we may take as our starting premise the fact that all dimensions obey the same rules. Considered in this way, the differences in the way our temporal dimension behaves as embodied in the two questions above are not so much 'real' (intrinsic to the dimension) as 'apparent' (the product of the observer's dimensional viewpoint). We have successfully shifted the problem, because the consistent nature of *Flatland* principles reveals that *the dilemma is not inherent in the physics per se, but in our perception of the world*.

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[a] This essay was abridged from Chapter 11, *The Magic Treadmill of Time*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Expansion of space; cosmic microwave-background radiation; quantities and distribution of hydrogen, helium and lithium; the Hawking-Penrose Singularity Theorems.

[c] EA Abbott's term.

[d] https://en.wikipedia.org/wiki/Spacetime - Accessed 29th Dec 2012

In *Flatland* terms, the 4th Dimension of our universe is not distinct and special; it is merely the fourth in a configuration that ascends in complexity[a] in such a way that – just as the line is composed of the close stacking of points and the plane of the close stacking of lines – each succeeding dimensional layer is composed of the close stacking of the last[b]. *Flatland* principles do not discriminate between dimensions, rendering the structure fairly straightforward, with all dimensions obeying the *Principle of Relationship*[c].

A 2D spacetime

Much to *A Square's* befuddlement, *Sphere* informed him of something about his flat world of which he was unaware: *"...what you call Space is really nothing but a great Plane."* However, as described in Essay 1, *Square's* experience of physical space was 1-Dimensional comprising the circle around him, so what he called space was actually a line. How then could it be a 'great Plane'? Clearly he *lives* on a plane[d] (no-one is disputing that Flatland is flat) but he does not *see* a plane because he exists level with the plane and views it in keeping with the *'Edge-On' Principle*[e]. *A Square's* plane is his entire universe-experience, and since *'relativity's mathematics works fine in any number of dimensions'*[f] we find that our Flatlander inhabits a 2D spacetime. (Again we must remember that Edwin Abbott Abbott lived in a pre-Einsteinian age in which the practical relationship between space and time was less well understood.) Therefore:

- Space, for *Square*, is the bit he sees, his edge-on view: a 1D circle.
- Time, for *Square*, is his 2nd Dimension, extending away from him all around.

The spoked cartwheel

A Square watches his world change because he finds himself moving across it. But to him all he is doing is changing the compass direction in which he is facing. Even so, as he does so his world changes. Why? Because he is also moving through his 2nd Dimension which in his spacetime is his last dimension, and as such 'behaves temporally'. But, *what does this actually mean?*

His 2nd Dimension is the means by which his world appears to change, continuously revealing to him a 'new' bit of 1D, and although from his perspective he cannot see the process in action, the 1D world around him changes. Just as it is for us, *A Square's* last dimension acts as his *means of change*, and without this last dimension, wherever the Flatlander turned everything on his circle would remain the same, frozen in one place. *But,* one might ask, *if he can't see his 2nd Dimension, how does he move through it?*

Although the Flatlander can spin around his 1D circle, we must consider that our Flatlander does not have the power to move at all into his 2nd Dimension. At this point the original *Flatland* allegory becomes

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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.

[c] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

[d] More precisely, he exists as an integral part of a plane.

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

[f] New Scientist, *Seeing Triple*, Matthew Chalmers, 28th Sept 2013

misleading because *A Square* would not have freedom to move around within the flatness of his world and we must clear our minds of this misconception. In a 2D spacetime he is rooted to the spot, and instead *his world moves beneath him*. Like a gigantic, rolling treadmill it trundles along completely independently of *A Square*. The effect this has is to alter the look of the world around him as his landscape moves inexorably forward. In this way his second degree of freedom acts as the means of change – or temporal dimension – within his world, modifying the characteristics and appearance of everything he experiences on his 1D circle.

Although it is the world that trundles by him and he has no influence over the rate at which it trundles, the Flatlander still retains the power to choose which spatial direction to face, because he may turn a full 360° at any speed he can muster. Existing within his 2D spacetime (*x,t*) *A Square's* last co-ordinate, or second degree of freedom, acts as time. *So why is it invisible?*

His 2nd Dimension is invisible because, any direction he looks, it points perpendicularly away from him and he views it point-on as the direction in which he is travelling just like viewing a needle point-on. And since a point is 0-Dimensional he sees nothing. It points radially away from him as though *A Square* were always at the hub of a spoked cartwheel, with himself continuously located at the centre. The radial nature of the last dimension explains why the Flatlander's time direction is invisible, and in so doing, as we shall see, answers our first question about time. (From this we see clearly that the Flatlander's experience of his world is observer-centric.)

The bubbling forth

All this begs the question… *'How can a rolling treadmill act radially?'* The treadmill analogy is limited; we must imagine that instead of standing on a rolling treadmill which acts only in one direction, the Flatlander is on a 'magic' treadmill that acts *in every direction* around him, as though he were standing on a vent and the ground is constantly bubbling up from beneath his feet like lava, or wet cement. As it bubbles forth it spreads out radially and flat in all compass directions in an ever-widening disk, but, as observer, he never gets carried away with it because he is always located at the centre of his own personal, observer-centric spacetime location.

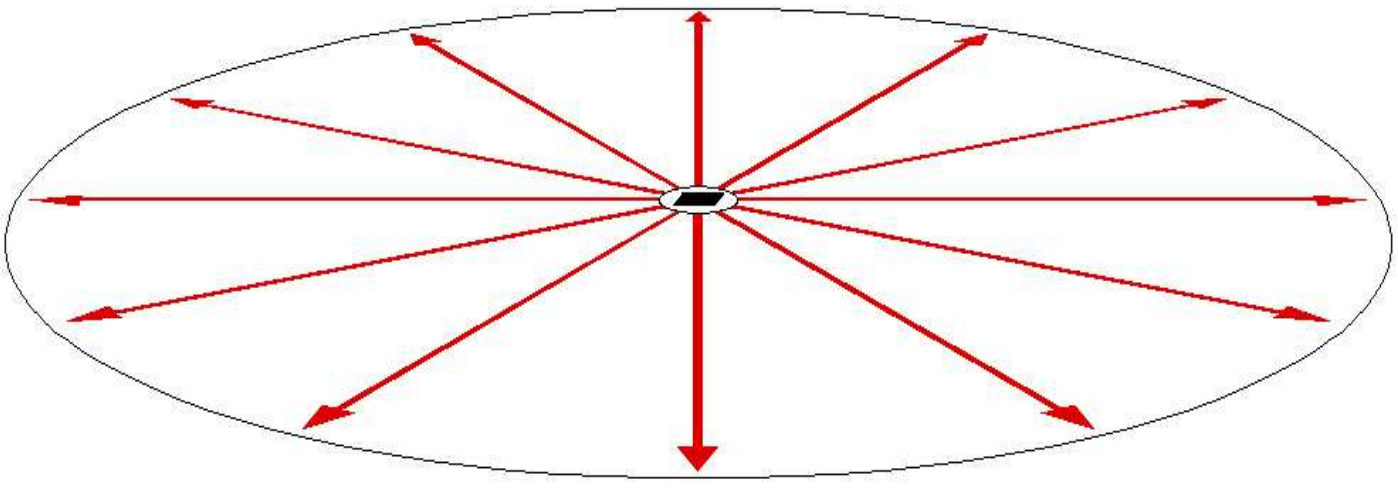


Fig.1 The magic treadmill in a 2D spacetime. The Flatlander exists at the centre of a 'spoked cartwheel'. He is hemmed in by a 1D circle in his moment now, which is jammed up against (i.e. integrated into) his perception. His 2nd Dimension 'emerges like lava' from his observer-location and heads away from him, expanding his spacetime into a 2D disk comprising his block universe. His 2nd (i.e. his last, or temporal) Dimension always points away from him, therefore he always views it 'point-on' like a needle pointing away from him in every direction. A point is 0D, therefore his 2nd Dimension remains forever invisible to him.

Note that the invisibility of the Flatlander's temporal dimension is the result of his viewpoint, and is not intrinsic to his 2nd Dimension. It will appear flat to anyone able to view it from above. Thus a *Flatland*-based dimensional structure shows time to obey the same consistent principles as space.

Ripples on a millpond

Because the Flatlander only senses in 1D, not only can he not get swept away from the centre with it, but *he cannot physically see the ever-widening patterns spreading out around him* because they are receding like ripples on a millpond into his past. His spreading 2D 'means of change' has 'meansed' all the change it is going to, and, instantly upon receding from his 1D perception-ring, has set like cement. It has become an unalterable yet ever-receding 2-Dimensional 'disk-shaped' storage facility for all the events that happened on his 1D circle, but are no longer happening. Each fixed circle that started out as his 1D space-experience in the present stacks as a receding 1D circular cross-section into the 2D disc. This disk forms his past, as the information the ripples encode can never change.

Notice however that *A Square's* actual past does not consist in *everything* on the widening disk – because the whole disk is the history of 'everything from his viewpoint' – but only those points on each circular ripple which represent the direction he was facing at that time, which may be traced like a squiggly scratch on an old vinyl LP. This is the Flatlander's world-line through his 2D spacetime.

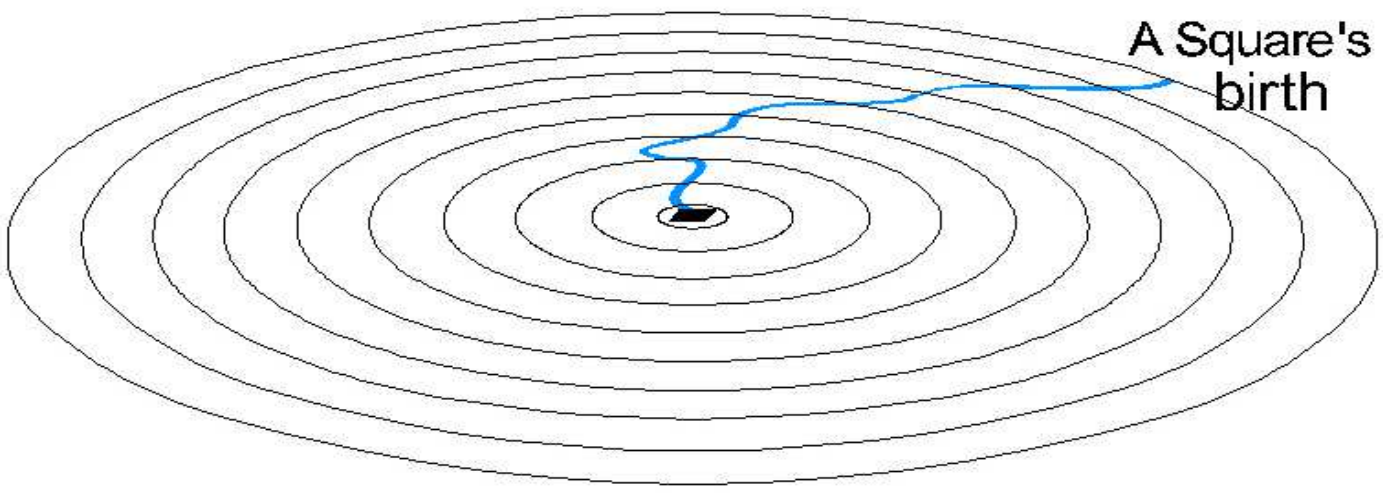
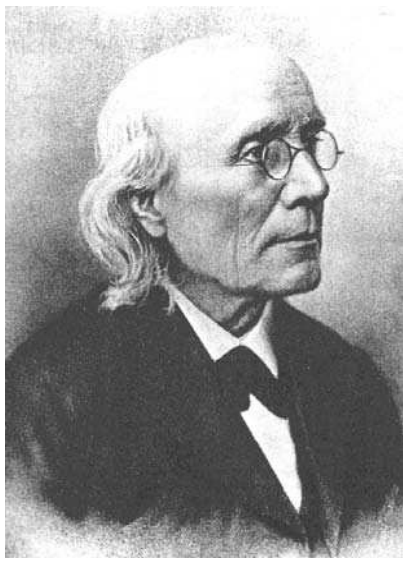


Fig.2 The Flatlander is located at the centre of his universe experience. As he turns on the spot to look around, his 2nd Dimension emanates from his unique observer-location, rippling away from him, presenting him with a constantly refreshed 1-Dimensional experience of the present on his encompassing circle. The squiggly line represents his world-line through his 2D block universe which continues to exist as a record of his past – forever unalterably out of reach, and consisting in all the directions on his 1D circle he has previously faced. This means that the Flatlander's origin is fixed forever on the outer rim of his ever-expanding past.

Time in 3D

Having broken down the experience of space and time by the simple expedient of reducing the number of dimensions to a manageable (but theoretical) two, we will now apply the *Principle of Relationship*[a], adding one more dimension to picture what would happen in a 3D spacetime (very briefly because this world is also theoretical). We will then add another dimension which will bring us up to our own 4D spacetime.

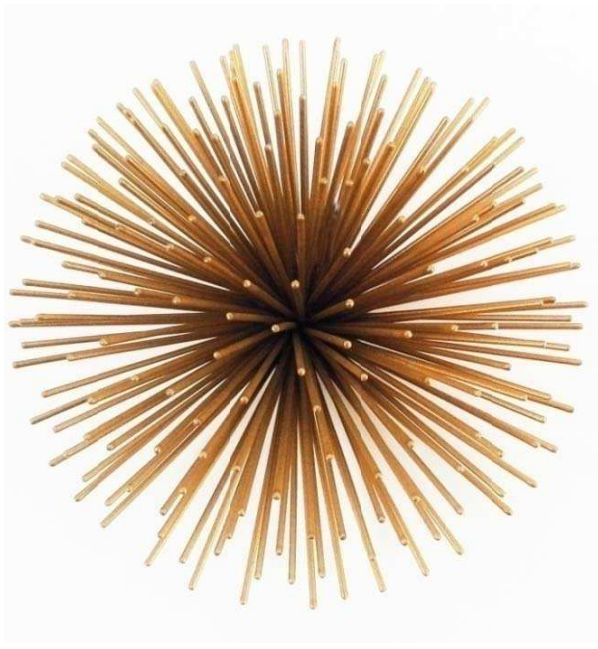
[a] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.



Gustav Fechner, 1801-87

EA Abbott was not the first to ponder the implications of Dimensionality. Consider Plato's celebrated shadow men who, before they escaped, spent their lives sitting in a row tied to chairs in a cave whilst a fire glowed behind them, blissfully unaware that their flickering shadows on the wall were not the sum total of their lives. Later, in the writings of pioneering German psychologist Gustav Fechner we hear echoes of Plato, however, in Fechner's world the shadows *are* the men. Professor Tom Banchoff of Brown University, a leading authority on EA Abbott's *Flatland*, writes: *'The first person to develop the dimensional analogy in the 19th century was the psychologist and physiologist Gustav Fechner in Leipzig. He wrote a small story,* ***Space has Four Dimensions****, as part of his collection* ***Vier Paradoxe*** *published in 1846 under the pseudonym of Dr. Mises. Fechner's two-dimensional creature was a shadow man projected to a vertical screen by an opaque projector. He could interact with other shadows, but, based on his limited experience, he could not conceive of a direction perpendicular to his screen.'*[a]
At first glance the shadow men's experience appears similar to Flatland, but Fechner is describing a 3-Dimensional spacetime (Spaceland) in which the protagonist is able to physically experience length *and* width. Banchoff continues: *'Fechner suggests that for such a being, time would be a third dimension, expressing the movement of his whole screen in a direction which he cannot comprehend spatially.'*[b]
Remembering that the Flatlander's 1D circle is integrated into his sensory perception we must somehow now picture the same for the Spacelander, one dimension up. As described in Essay 1, the Spacelander exists at the centre of his spherical environment. He indwells the 2D surface of a sphere, experiencing his two spatial dimensions of length and width as flatness at zero extended distance, integrated into his perception as though he has been vacuum-packed by its enfolding surface. These two dimensions, for him, constitute space. *'For such a being,'* as Fechner observes, *'time would be a third dimension'*.

His third dimension of depth is always perpendicular to his experience and extends radially away from him in every direction as though he were at the centre of a 'dandelion head', or spiky ball. This is the 3D analogue of the Flatlander's 2D spoked cartwheel, and in the same way his last (i.e. 3rd) dimension – acting as his means of change – remains physically invisible to him, because no matter which direction he faces he views it point-on in 0D.



The 3D analogue of the Flatlander's spoked cartwheel.

He is experiencing the stacking of his 2D world into his 3rd Dimension by the same magic treadmill mechanism described above, except the Spacelander's treadmill is not 2D but 3D, radiating away from him any direction he faces in the way that light rays radiate from the sun. And instead of ripples, his 2D world flows out onion skin-style to solidify into his 3D past like the spherical shockwaves of a supernova, recording all events that have taken place in the flatscreen 'now' of his universe from his unique spacetime location. Each receding spherical (onion skin) cross-section

[a] http://www.math.brown.edu/~banchoff/gc/ISR/ISR.html - Accessed 19th March 2016
[b] Ibid. - Accessed 16th Oct 2016

represents the 2D (2-sphere) surface of his universe as it was at a moment in his past, with the whole containing all events in his 3D (3-ball) block universe from his dimensional viewpoint.

Like the Flatlander his universe experience is observer-centric. His spacetime is what we would experience as a ball, and, like the Flatlander, his world-line traces a squiggly line into his past with the difference that this line wends its way through three degrees of freedom, like a loose strand of wool connecting the centre of the ball to the edge. Again his origin event – conception/birth – is located on its (2-sphere) surface, whilst the whole ball is the history of 'everything from his viewpoint'.

Time in 4D

Because *Flatland* geometry is dimensionally consistent, all these same principles are at work within our own 'real' 4D spacetime, in which our last dimension acts as the means of change. Again by applying the *Principle of Relationship*[a] our 4th Dimension points radially 'away' from the spacetime location of the observer and as a result we see nothing, which is why the 4th Dimension gives us the impression that it is 'non-spatial'. For us this pointing away takes place in a fourth direction rather than a third or second as in Spaceland or Flatland, but it is important to stress that this makes no difference to the principle. Time, although genuinely our 4th Dimension, is *viewed by us point-on* as a 0-Dimensional point, spraying radially away from *each and every spacetime event* in the same way as light radiates from the sun. From the observer's dimensional viewpoint the 4th Dimension is thereby rendered invisible, whilst we constantly observe the lower three dimensions changing form.

Crucially, this radial direction is not depth. The 3-Dimensionality of our world exists at zero extended distance from us. It may seem strange to think of 3D in this way but we are totally immersed within it, our bodies are made from it, and it is integrated into our sensory perception in precisely the same way as the Flatlander's 1D circle and the Spacelander's 2D spherical vacuum pack. Each one of us 'stands over a 4D vent' with 3D jammed against our perception. We experience the influence of this 4th direction as 3-Dimensional change, feeling ourselves moving into all-new 3D scenarios as they spring continuously from each and every spacetime event in the universe so far, 'bubbling up' to form all the physicality of that observer-location's moment now and receding like 4D ripples in a 4D pond, setting firm to form the block universe, fused forever (by the *Principle of Character*[b]) into a permanent record of the events in which it consists. This is the 3rd Dimension stacking into the 4th to form what we from our geometrical standpoint call the past.

'But if I cannot see it because I am always at the centre, why can't others see it around me, or I them?' It may be wrong to think of ourselves as not seeing it because, although we don't experience it physically, we may be viewing the 'already stacked' 3rd Dimension all the time in our mind's eye[c]. However the reason we don't *physically* see it pointing away from ourselves or someone else is because it is 3D alone – which we

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[a] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

[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.

[c] Although not directly relevant here, this may be a clue to the dimensional nature of memory and consciousness. This is explored more fully in Sections 7 and 8 of the author's book on which these essays are based: *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

call ‘spatial’ – that makes up the physical world for all observers, experienced always in the present. Setting the process out more formally:

> *The Magic Treadmill Principle:*
> **Time, as the *n*th Dimension in an *n*Dimensional spacetime, issues forth perpendicularly and radially from within the frame of reference of each spacetime event. To the observer this *n*th Dimension appears 0-Dimensional (is viewed 'point-on') and is therefore invisible, but results in (*n*-1)Dimensional change, and stacking of the (*n*-1)D surface into the *n*th Dimension, taking the form of the past.**

Throughout the *n*D spacetime itself (i.e. an *n*D universe) this process continues from its origin at a singularity to its completion at a singularity one dimension higher[a], between which it forms the whole *n*th Dimension. The magic treadmill describes a continuous 'outpouring of more universe' from each and every spacetime event constituting an ‘observer-location’[b] at the centre of an observable universe. In this way the observer is located at the centre of an expanding 3D spherical cross-section of the 4D hyperspherical universe[c]. Now to our second question: time’s unidirectionality.

The arrow of time

Were we somehow able to view our 4D universe from outwith the dimensional structure we would view it as a static rather than dynamic entity, consisting in four ‘spatial’ dimensions which are the 4D analogue of the Flatlander’s 2D ‘length+width’ and the Spacelander’s 3D ‘length+width+depth’ spacetimes. Its dynamic ‘flow’ is our (*n*-1)D view[d], corresponding to the stacking process *as experienced from within* the dimensional structure in keeping with the *Flatland*-derived:

> *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.**

This geometrical principle, foundational to *Flatland*, does not simply describe a final state, but a process. Stacking persists as a dynamic within the dimensional structure as 3D slices stack up ‘one by one’ to mould the fused character of the next dimension, the 4th, in accordance with the *Principle of Character*[e], resulting in each spacetime event taking up a unique co-ordinate location (x,y,z,t)[f]. Rather than ‘dismantling’ and

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[a] Corresponding analogically to *Sphere’s* points of entry and exit from Flatland, here a singularity represents a dimensional ambiguity similar to the phase change between ice and water wherein a dimension transitions from its form as completed *n*D to its new role as the first stacking cross-section of (*n*+1)D.

[b] An observer-location need not be conscious, but designates the experience of the universe from any spacetime location.

[c] See Essay 3

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

[e] *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.

[f] We may conveniently think of these as uniquely discrete points perhaps related to the Planck quantities, although in reality the dimensional structure may be unlikely to possess points as such. We are not primarily concerned here with the actual constituent nature of the physical world, but geometrical principles governing all interactions at a fundamental level.

winding down as per entropy, stacking may drive (or pull) to completion the nested hierarchy in which everything consists, as each dimension graduates into its own unique nature[a].

Like entropy, our empirical experience of stacking causes it to appear as a one-way process. However the two are in a sense opposite, because stacking describes a movement from beginnings through to endings, from 'nothing yet' to 'something'. Whilst Newton's Second Law of Thermodynamics[b] is clearly at work in the universe and time's unidirectionality is often attributed to it, dimensional stacking may be the more fundamental for the reason that its influence is positive. Another possibility is that stacking counterbalances entropy in the sense that it describes the 'filling of the glass' whilst entropy describes the corresponding 'emptying', such that these two values describe the universe's state at any instance of the present.

So, by means of stacking Dimensionality may describe the *direction* of the arrow of time, but it cannot explain the *existence* of the arrow of time any more than it can explain the existence of anything. Instead what it does is to add to this queen of mysteries another: the *a priori* idea of stacking as fundamental, of which time's arrow may simply be, in terms of the overall dimensional structure, a special case.

Time's arrow is a special case of stacking because stacking applies in principle between *all* dimensions; the arrow of time reveals the action of stacking in our experience only between the 3rd and 4th Dimensions.

In terms of Einstein's *'four-dimensional continuum'*[c] and the physicist's block universe, although it *feels* as though it is me who is moving steadily through time I am actually at rest in a static 4th Dimension like an elongated man-shaped worm, at one end of which I am a baby and the other end a corpse. In that sense the dynamic I experience as my life does not primarily consist in movement – through time or otherwise – but the perceived process of becoming stacked. Principles derived from EA Abbott's 1884 *Flatland: A Romance of Many Dimensions* describe the operation of this phenomenon whilst crucially preserving the same consistent rules for our 'temporal' and 'spatial' dimensions.

Conclusion

Within a consistent dimensional structure based on principles derived from *Flatland* (listed in *Appendix 1*), the magic treadmill mechanism describes how every observer-location – i.e. spacetime event – exists at the centre of its own radially expanding 4D 'dandelion head', from which the 3rd Dimension emerges continuously to radiate spherically away, forming the 4-Dimensional 'block universe'. Both the 2D Flatlander and the 3D Spacelander view their last dimension (the *n*th Dimension in an *n*D spacetime) point-on, and therefore, by extrapolation, we view our last dimension 'point-on' as 0-Dimensional, thus answering in terms of *Flatland* geometry the philosophical question of the invisibility of time. By the process of dimensional stacking, 3D experience wells up through me and every other spacetime event (as observer) to form a 4th Dimension where – as surely as I exist now – I exist in my past and will[d] in my future. In the

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[a] *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.

[b] Oxford Dictionary: *'the Second Law of Thermodynamics says that entropy always increases with time'.* https://en.oxforddictionaries.com/definition/entropy - Accessed 16th Oct 2016

[c] Albert Einstein, *Relativity, Appendix 5*, Routledge 2001, P151

[d] 'Will' in terms of perception from within, but 'already do' in terms of the structure as a whole.

meantime, although I have no influence over the rate at which stacking occurs[a], as per the Flatlander's 1D spin I am free to decide by deploying my physical senses in which combination of three directions to face before the 4D lava sets.

Developing this further: if, instead of simply a disk, we allow that the Flatlander's spacetime is the 2D surface (2-sphere) of a ball, his origin event occurs at his polar opposite point, viewed by him in all directions (see *Fig.1*) as emanating from (i.e. like lines of longitude having crossed) an equator. This is similar in principle to how the origin of our universe is always viewed as located on the expanding outer surface of our observable universe, yet emanates from a point.
This is not a coincidence, but evidence of the consistent nature of the dimensional structure, showing the derivation from *Flatland*-derived principles of the antipodal locations of observer and origin within the 3-sphere observable universe. See Essays 3-5 [b]

[a] As will be seen, it is consistent with the structure that this unfolds in accordance with Special Relativity at the constant *c*: the invariant which rules all the variables of time, velocity, mass etc.
[b] Especially Essay 5, P40, Footnote *b*

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 3/15:

In a *Flatland*-based dimensional structure the observer is located at the centre of one 3-sphere cross-section of the 4-ball (block) universe

Abstract

The application of *Flatland* geometrical principles renders the sphere of the observer's 'observable universe' a 3D cross-section of the hyperspherical (4-ball) universe. Because the Big Bang origin event is viewed by all observers as having occurred on the surface of the observable sphere, the restriction of lightspeed means that all observers view the same event at different aspects. The observer's view in the present is one unique, observer-centric, spherical 3D cross-section through both space and time.

Sphericality

Physicist Marcelo Gleiser writes: *'If the Universe were shaped like a sphere, as Einstein wanted...'*[b] The reasoning, as Einstein wrote in 1916, is that a spherical surface is mathematically preferred *'since all points on it are equivalent'*[c]. EA Abbott's *Flatland* pre-dates General Relativity (GR) by three decades, therefore the Dutch mathematician Dionys Burger updated its geometry with his 1965 book *Sphereland*[d] wherein he has *Sphere* inform *A Square* and his new friend *Mr Puncto*, *"You are not living on an infinitely large, flat plane but on a spherical surface."* In other words, if reality comprises a *Flatland*-style nested hierarchy it would not offend Einstein were it to be grounded in sphericality. This same conclusion was arrived at in Essay 1 by extrapolation – in keeping with the *Principle of Relationship*[e] – of the Flatlander's 1D (circular) perception[f] of his 2D (spacetime) world. As a result we are now in a position to describe the ascending dimensional structure and its accompanying *Flatland* analogies in geometrically spherical terms.

Infinity

Just as relativistic geometry may be accessed by extending Pythagoras' Theorem from two dimensions into four, the principles involved in the idea of 3-Dimensionality slicing through a 4th Dimension generate straightforward explanations for several mysteries of the universe which we will examine over this series of essays. At their root is the dimensional relation between the observable universe and the universe 'proper'. However, separating the two is not straightforward as this difference is often considered merely a question of scale: the observable bubble is regarded as part of a far greater 3-Dimensional whole which it achieves by being either infinite (flat or negatively curved in 4D) or finite (spherical in 4D). Cosmologist Max Tegmark

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[a] This essay was abridged from Chapter 25, *Two Different Ball Games*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Marcelo Gleiser, *The Island of Knowledge*, Basic Books 2015, P97

[c] Albert Einstein, *Relativity, Section 31*, Routledge 2001, P113

[d] Dionys Burger, *Sphereland*, Harper & Row 1983, P157

[e] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

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

of MIT, whose painstaking work on CMB data has proved invaluable, simply states that, *'...we have no reason to doubt that such galaxies [outwith the observable universe] exist'*[a].

As has Tegmark, topologists such as Janna Levin and Neil Cornish[b] have scoured the sky for signs of repeating patterns which would indicate that light has done a round tour, but found none. On this empirical basis sphericality has been largely ruled out[c]. Setting aside the misgivings of a previous generation regarding infinity, flat and infinite seems increasingly to be gaining favour, although this is by no means unanimous. Janna Levin of Columbia University, whilst deeply appreciative of the infinite in the mathematics of Cantor, would be *'pretty shaken'*[d] to find it in nature, declaring: *'Still, I don't believe in the physically infinite.'*[e] And although Tegmark is the architect of the 'levels 1-4' multiverse classification[f], in a short essay he expresses his own heartfelt doubt: *'Not only do we lack evidence for the infinite but we don't need the infinite to do physics... So if we can do without infinity to figure out what happens next, surely nature can, too – in a way that's more deep and elegant than the hacks we use for our computer simulations. Our challenge as physicists is to discover this elegant way and the infinity-free equations describing it – the true laws of physics. To start this search in earnest, we need to question infinity. I'm betting that we also need to let go of it.'*[g]

Infinite or not, the one thing everyone seems to be agreed on is that, whatever the universe's 'shape', it has to stretch off beyond the observable radius that forms the cosmological horizon, far beyond the bit that the speed of light will allow us to observe.

The snooker ball universe

Science writer Marcus Chown describes the natural consequence of the theory of Cosmic Inflation: *'So our observable universe is akin to a bubble and beyond it lies an infinite number of other bubbles that have a similarly restricted view.'*[h] However, our conventional picture of the universe may simply be rooted in the limitations of the 3-Dimensional mind and for that reason fatally flawed. The observable sphere is thought of like a snooker ball and the universe as a bag; the bag is filled with snooker balls and all we are trying to do is figure out the properties of the bag. However, *Flatland* principles point to the fact that we must guard against visualising a higher dimension as a simple collection of lower ones. If we are to grant the observable universe due respect as a 3D spherical cross-section through a greater 4D whole – and our earlier *Flatland* extrapolations suggest that this is reasonable – we must accept that a dimensional cross-section does not behave like a snooker ball. One of the most basic principles embodied within *Flatland* may be expressed as follows:

> *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.**

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[a] Max Tegmark, *Our Mathematical Universe*, Penguin 2015, P47
[b] https://arxiv.org/abs/astro-ph/0310233v1
[c] This is discussed in Essay 7, where it is shown that light cannot circumnavigate a finite observer-centric universe.
[d] Janna Levin, *How the Universe Got Its Spots*, Phoenix 2003, P15
[e] Ibid., P14
[f] An implication of Inflationary theory.
[g] Max Tegmark, *Infinity*, from *This Idea Must Die*, Edited by John Brockman, Harper Perennial 2015, P51
[h] New Scientist/The Collection, Vol 1 Issue 1, 2014, Marcus Chown, *Is there more than one of me?*, P29

As the nested hierarchy builds, each new dimension graduates into an entity that is greater than the sum of its parts[a]. To confuse the two universes – observable and global[b] – leads straight into the jaws of a fatal dimensional error; one based on an incorrect application of the stacking and cross-sectional behaviour of the 3rd Dimension (which we see) in relation to the 4th (which we don't). It is essential to the whole enquiry that we permit the way that one dimension is viewed from another to set the relationship between the universe as observed and the universe as is. The key is to remember that we are dealing with two very different entities which must be held in tension at all times:

- The *spherical* 3D observable universe (3-sphere), and
- The *hyperspherical* 4D block universe (4-ball)

US mathematician Rudy Rucker writes: *'...a hypersphere is a four-dimensional stack of spheres'*[c]. With this he reminds us that the position is not conceptually straightforward. Extrapolating consistently on the basis of *Flatland* geometry we find that, as a finite hypersphere, the universe proper is not an infinitely extending compendium of observable universes, but a 4-Dimensional stack of 3D 'light spheres'. The difference will become clear as we apply the principles of *Flatland*.

The unique observer

By the 'observable universe' astronomers mean the bit we can see or theoretically detect due to the speed of light, which takes the form of a sphere around us. However this term tends to be used as though we on Earth all see the same thing. Because space is so vast and the observable universe is *virtually* identical for any observer located in the vicinity of our Solar System, the observable universe is described, in *Wikipedia* for example, as *'centered on Earth'*[d]. Although this serves as a 'Newtonian-style' working approximation, in seeking to understand the universe as a whole it may in fact be one generalisation too far, because *your* observable universe and *my* observable universe are not the same. Four people standing loosely in a line, viewing the night sky, do not see the same thing, because each of their centres will be a few metres apart. The light sphere of the observable universe is not centred on the Earth, but <u>the observer</u>. The sheer size of the universe makes this sound like splitting hairs, however, by taking this observational nuance for granted we may be missing something of great dimensional import, holding power to unlock several enduring mysteries of our cosmos.

[a] *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.
[b] The universe proper is called global, not because it is presumed spherical, but because it is everywhere that is.
[c] Rudy Rucker, *The Fourth Dimension*, Houghton Mifflin Company 1884, P19
[d] https://en.wikipedia.org/wiki/Observable_universe - Accessed 2nd Aug 2015

The origin event is located on the surface

Shortly after the Big Bang the cosmic microwave-background radiation (CMB) flashed into being at virtually every point in space which means we are all 'viewing' it 13.8 billion years later, and to someone located far away in the universe the light from the CMB that originated near us would still be arriving. In this way relic radiation permeates the universe. For each observer the finite speed of light renders the origin fixed at the maximum observable radius with the CMB released in the immediate aftermath of creation[a] just short of that distance. In this way, each light sphere is a unique 3-Dimensional cross-section through the whole of space and time – from the Big Bang event observed as having occurred on its 2D surface down through history to the observer at its centre in the moment now. The hyperspherical universe therefore possesses as many centres (i.e. observer locations) as there are spacetime events within it, each with its own distinctively unique view of the cosmos. As observers, each of us moves around within our own 'observable universe experience', always located at a unique centre in space and time.

Because there was only one origin event, the origin on the edge of every light sphere *must be the same*. Although viewed at different aspects, each light sphere centre therefore shares a view of the same event. The observable universe, as experienced by all observers, therefore possesses one single perimeter at the extreme spherical surface of the observable distance with multiple centres in the 4D spacetime continuum, each of which is the centre of one individual 3D spherical cross-section through the 4-ball universe in one observer's present. Although each 3-sphere is centred on a different spacetime event which may be located anywhere in the global universe[b], the inward radiation of light from the uniform and unchanging origin that converges on the moment now indicates that the light sphere expands like a balloon being pumped up *from the centre* by the passage of time. We may imagine ways in which the universe stretches off beyond the spherical horizon but if our light sphere is one 3D cross-sectional 'ice core' through space and time, then that stretching off is not a 3D, but a 4D phenomenon. Here it becomes essential that we apply the principles of *Flatland*.

Sphericality surrounding the observer

How can we imagine all this? The truth is we can't, fully, but what we must not do is think of the universe *itself* 3-Dimensionally. To do so is to fall into exactly the same trap that our forebears did but up by one dimension. The ancients viewed the sky as an Earth-sized planetarium comprising the flat inner surface of a 3-Dimensional (hemi)sphere through which shone all the mystifying lights. Nowadays, with all the benefits of modernity we know that the lights hang within a 3-Dimensional space – however, *this is up by just one dimension from the flatness of the ancients' dome*. They saw 2D which formed the surface of 3-Dimensional space; we see 3D which forms the surface of 4-Dimensional hyperspace.

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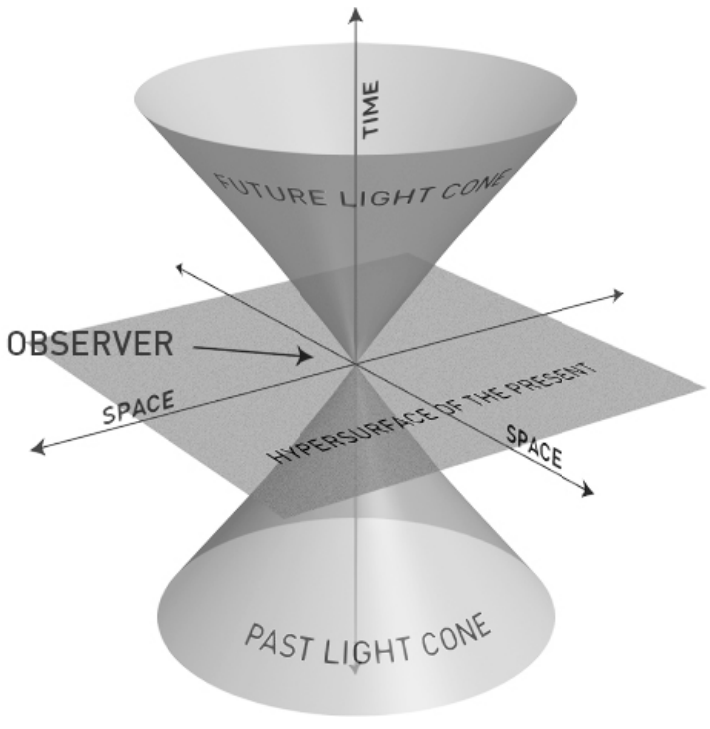
[a] About 380,000 years.

[b] I.e. anywhere in space and time, because the 4-Dimensional universe comprises all observer locations stacked up in the same sense as *Sphere's* explanation to *A Square* that *"I am many Circles in one,"* (Flatland Ch15).

Each observer's light sphere centre corresponds to the point at which the light cone intersects the plane called the *hypersurface of the present*. In the light cone physicists 'cheat', representing the world as 2D by removing the dimension of height in order to visualise the time dimension by plotting it vertically. The *hypersurface of the present* represents our 3-Dimensional world in which, in reality, the time axis *t* points in a 4th direction which we cannot visualise or represent spatially. Shifted up to the real world this 2D plane becomes 3D space and the whole illustration goes spherical[a]. Light converges from every direction to 'pass through' the observer with the upper and lower cones now occupying the same shrinking (arriving) and expanding (departing) ball in space through time. The arriving ball (corresponding to the upper cone) represents the sphere of the observable universe.



Because light from the extreme spherical surface passes through each observer location, the global universe comprises the sum total of all locations from which the same origin event may be viewed at maximum distance but at differing aspects. It is therefore overly simplistic and dimensionally inconsistent to think of the universe as extending indefinitely beyond the cosmic horizon at the boundary of the observable universe, because it is the location of the origin for all observers. In this way, these myriad 3-sphere observable universes centred on every spacetime event stack up to form Rudy Rucker's *'four-dimensional stack of spheres'*[b] in keeping with the *Principle of Relationship*[c], and in so doing obey the consistent principles of *Flatland*. Comprising all observer points, the 4-ball extends through all of space and all of time and is therefore synonymous with the block universe.

Conclusion

- Each observer occupies the centre of an observable universe, or light sphere.
- There are as many observer locations as there are spacetime events.
- Each observer views the 4D universe in spherical cross-section, in keeping with the *Flatland*-derived *'Edge-On' Principle*[d] which results in perception by all the senses of a physically 3D universe.
- The origin is a fixed historical event, viewed by each observer at the maximum radius[e] at a unique 3D aspect within the universe's finite 4D shape.

As a 4D entity the universe is 'space-*and*-time-shaped', which is why when we gaze out into it we see not merely distance, but history. As a cross-section of a hypersphere is a sphere, *the observable universe behaves as a 3D spherical cross-section of the 4D global universe*, placing the observer at not only spatial, but temporal 'distance' from the origin. Possessing the spherical geometry of a 4-ball, the universe may

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[a] Roger Penrose, *Cycles of Time*, Vintage 2011, P83
[b] Rudy Rucker, *The Fourth Dimension*, Houghton Mifflin Company 1884, P19
[c] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.
[d] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.
[e] Currently measured at a look-back distance of 13.82 billion light years.

only be fully expressed by the smoothly continuous combination of every discrete ‘snapshot’ from every location in space through the whole of time: past, present and future. In keeping with the *Flatland*-derived *Principle of Character*[a], all 3D spherical slices meld together to form the 4D character of the block universe.

[a] *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.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 4/15:

The uniformity of the cosmic microwave-background radiation is explained by means of the 'Antarctica' lensing effect produced by a spherically finite 4-ball/3-sphere universe with observer and origin at polar antipodes

Abstract

The extraordinary uniformity of temperature displayed by the cosmic microwave-background radiation (CMB) – known as the Horizon Problem – is currently an enigma. In this essay it will be shown how this is resolved within the finite 4-ball/3-sphere universe (with observer and origin located at polar antipodes) by means of the 'Antarctica effect', describing spherically convergent light from a single source which is viewed as having passed through (crossed) the 2D equator. Inflationary explanations are thus rendered redundant.

The distant universe

German philosopher of science Hans Reichenbach, who was one of only five students to attend Einstein's first seminar on General Relativity, wrote in 1927: *'Mathematical space is a **conceptual structure**, and as such ideal. Physics has the task of coordinating one of these mathematical structures to **reality**.'* [Emphasis his][b] In other words, all the universe may be maths but not all maths is the universe, and nearly a century on from Reichenbach's exertions the task of physics remains largely incomplete. Of the many existing models of the universe, the most widely accepted is the Friedman-Lemaître-Robertson-Walker metric (FLRW) or Big Bang model, independently developed during the 1920s and 30s by the four named authors and considered the Standard Model of modern cosmology. Although current measurements are deemed insufficient to discern whether the universe deviates from flatness such that it might possess global curvature, the model allows for a hyperspherical interpretation based on the 4-Dimensions of spacetime.

We view the distant universe not as it is but as it was, because the movement of photons is limited by the speed of light, and the farther into space we look, the less accurate our picture in terms of the 'current' state of things. Although we may know how the farthest reaches of the universe were, how they are now[c] remains an 'assumption' based largely on the Cosmological Principle. So what do the most distant parts of the universe look like? Sadly this may never be confirmed by observation or experiment, therefore if science is ever to come to any conclusions these will have to rely on the application of mathematical principles to what is already known. Because of this, what I am about to describe is not mere speculation, but a model of the universe which not only fits with observation, but provides straightforward explanations for several phenomena currently regarded as anomalies, beginning here with the uniformity of the CMB.

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[a] This essay was abridged from Chapter 26, *Poles Apart (CMB Uniformity)*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Hans Reichenbach, *The Philosophy of Space and Time*, Dover 1957, P287

[c] Although Einstein showed that 'The idea that a well-defined *now* exists throughout the universe is an illusion, an illegitimate extrapolation of our own experience.' Carlo Rovelli, *The Order of Time*, Penguin 2017, P40

The Horizon Problem

Astronomers wrestle over the issue of how the ancient light of the CMB that streams in from opposite sides of the sky appears so uniform, yet the sides are much too far apart for causal contact to have occured. Science writer Nick Strobel writes: *'The photons from the microwave background have been traveling nearly the age of the universe to reach us right now. Those photons have certainly not had the time to travel across the entire universe to the regions in the opposite direction from which they came. Yet when astronomers look in the opposite directions, they see that the microwave background looks the same to very high precision.'*[a]

Theoretical physicist Matt Strassler: *'...how did parts that are so incredibly distant from one another end up with the same temperature to one part in 100,000?'*[b]

Stephen Hawking: *'In the hot big bang model... there was not enough time in the early universe for heat to have flowed from one region to another. This means that the initial state of the universe would have to have had exactly the same temperature everywhere in order to account for the fact that the microwave background has the same temperature in every direction we look.'*[c]

Nick Strobel: *'Running the expansion backward, astronomers find that regions even a degree apart in angular separation on our sky would have been beyond each other's horizons at the time the microwave background was produced.'*[d]

And finally Alan Guth: *'To explain, for example, how the universe could have smoothed itself out to achieve the uniformity of temperature we observe today in the cosmic background radiation, one finds that in the context of the standard Big Bang theory it would be necessary for energy and information to be transmitted across the universe at about a hundred times the speed of light.'*[e]

Clearly light cannot exceed the speed of light, however it is clear to astronomers that these two extremes – the opposite sides of the sky – *must* at one time have been in causal contact. The Horizon Problem is a serious enigma and various ideas have been put forward to account for it, the most widely accepted being Inflationary theory, originated in 1980 by Alan Guth of MIT. Hawking again: *'According to Guth, the radius of the universe increased by a million million million million million (1 with thirty zeros after it) times in only a tiny fraction of a second.'*[f] But whilst Inflation has been largely accepted by the mainstream[g], it throws up a glaring quandary: as an event it had *a beginning* and *an end*, and no definitive cause can be found to account for either. In that sense it smacks of a 'rescue package', an arbitrary fix. Guth himself describes it as an *'add-on'*[h], and his colleague at MIT, Max Tegmark writes: *'I have to confess that, although this process doesn't violate the laws of physics, it makes me nervous. I just can't shake the uneasy feeling that I'm living in a Ponzi scheme of cosmic proportions.'*[i] This is the natural outcome of a scenario that was contrived to force the two sides of the sky into subluminal contact. The following model shows how they were both emitted at lightspeed from the same source.

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[a] http://www.astronomynotes.com/cosmolgy/s12.htm - Accessed 25th July 2016
[b] http://profmattstrassler.com/2014/03/21/did-the-universe-begin-with-a-singularity - Accessed 17th May 2016
[c] Stephen Hawking, *A Brief History of Time*, Bantam Books 1995, P140
[d] http://www.astronomynotes.com/cosmolgy/s12.htm - Accessed 25th July 2016
[e] Alan Guth, *The Inflationary Universe*, from *The Universe*, Edited by John Brockman, Harper Perennial 2014, P24
[f] Stephen Hawking, *A Brief History of Time*, Bantam Books 1995, P141
[g] Reluctantly by some, because it rests on infinity and leads to the multiverse. Paul Steinhardt of Princeton, one of the theory's original architects, is now one of its most outspoken detractors.
[h] Alan Guth, *A Golden Age of Cosmology*, from *The Universe*, Edited by John Brockman, Harper Perennial 2014, P2
[i] Max Tegmark, *Our Mathematical Universe*, Penguin 2015, P105

Edge-on

Earlier, in Essay 1, I extrapolated the Flatlander's viewpoint up by two dimensions, which revealed the universe proper (inhabited by our character *Abbott*) to be spherically finite in 4-Dimensions. Unfortunately we can neither see nor imagine in 4D. Shape *per se* is therefore, I believe, the wrong way to think about it; suffice to say that the universe *may be represented mathematically* by a 4-ball. We must allow the block universe to be whatever it is in the 4th Dimension and concentrate on how that presents itself to our view in 3-Dimensions. To access this the question we need to ask is, *'What is the relationship between the two?'*

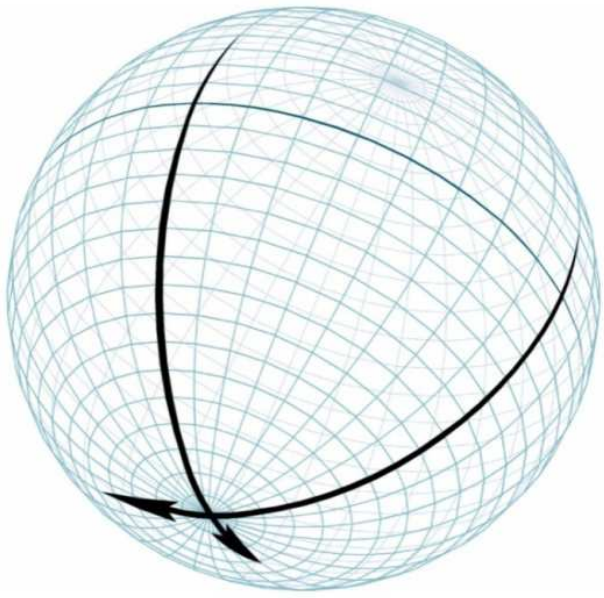
Flatland geometry shows that an inhabitant of an *n*D universe will view her universe one dimension down[a], in (*n*-1)D. In the real world this simple *Flatland* observation explains why we experience the world around us in 3D: *the universe itself* is 4D. We will now apply this to the behaviour of light from the origin as it arrives at us from the extreme surface of the observable universe, and by the application of basic geometrical principles embodied in EA Abbott's *Flatland* it should be possible for us to work out the 3-Dimensional properties of the observable universe. Over this series of essays I will describe a model of the universe as a hypersphere (4-ball) having the property that its 3-sphere surface is divided mathematically into two 'halves', corresponding – up by one dimension – to the northern and southern hemispheres of a globe. This is the finite spherical universe of Einstein [1916] but with the crucial difference that observer and origin occupy opposite 'polar' antipodes.

The globe analogy

Our starting premise is that light has set out radially in all directions from all points on the 3D surface of the hypersphere, i.e. everywhere. We will begin by asking, *'What is the nature of the path that relic radiation is on?'*

In reality the CMB set out uniformly from *virtually* every point in the universe 380,000 years *after* the origin at the 'surface of last scattering', and our current position in relation to it (as a fellow object) has moved very slightly over deep time. However, as the release of the CMB was, like the Big Bang singularity itself, an everywhere-event, for our purposes we will treat this as a technicality and extrapolate theoretically right back into the origin (in relation to which the observer has not drifted).

Professor Frank Close of Oxford University counsels us to *'Recall that Einstein's original inspiration came from the two-dimensional surface of the Earth, which is curved in a third dimension.'*[b] In the same way we may gain visual access to the 4th Dimension by using this analogy. We will now shift the scenario down by one dimension, picturing the 4D universe in 3D like the globe[c] of the Earth. On this globe I now visualise the Big Bang as having occurred at the north pole, with myself as observer standing at the south pole. The light's path follows



[a] *The 'Edge-On' Principle:* Each dimension is viewed from within itself one dimension lower.
[b] Frank Close, *Nothing: A Very Short Introduction*, Oxford 2009, P84
[c] Mathematically the 2-sphere surface of a 3-ball, although physicists might describe it as the 2D surface of a sphere.

the globe's 2-Dimensional surface, radiating in all directions from the north pole and crossing the equator. When the beams arrive at me at the south pole they criss-cross each other and keep going. In this scenario light beams follow the lines of longitude, tracing out great circles (geodesics) all around the globe.

3-ball[a] with 2-sphere surface:

Now, *beginning with this analogy* let's carefully describe the situation, breaking it down into a series of simple geometrical statements which we hold to be true. On the globe's surface the following take place:

1) Light sets off, travelling out in every 2D direction from its origin at the north pole.
2) It radiates out along lines of longitude to arrive at me.
3) I stand at the opposite pole (antipode) from the light's origin.
4) The light crosses the 1D equator, where beams which left in opposite directions reach their maximum distance apart (the diameter of the globe).
5) At the south pole, I see the light coming at me from every direction along the flat surface of the globe.
6) I do not see its origin at the north pole, I only see it coming at me from the equator.
7) Every light beam converges and crosses over at me.
8) After the crossover each light beam continues on its path which, instead of shining away from its origin, now heads back toward its origin.
9) The light beams re-cross the equator and criss-cross at the north pole, repeating the journey.

4-ball[b] with 3-sphere surface:

Now, shifting up to the *actual universe* by applying our *Flatland*-derived *Principle of Relationship*[c] let's replicate each statement to describe by extrapolation what takes place one dimension higher:

1) Light sets off, travelling away from the Big Bang in every direction from every point of origin.
2) It radiates out (like light from the sun) in every 3D direction away from each origin, with light from one of these[d] corresponding to the 'north' pole travelling across (through) the universe's 3D surface to arrive at me.
3) I, as observer, stand at a single point which is (hyperspherically) polar opposite *one* of the myriad single points of origin from which light left.
4) On its journey to me (which takes the lifetime of the universe) the light crosses the universe's 2-Dimensional 'equator' at which each beam is a maximum possible distance apart from its diametrically opposite beam.
5) Because I, as observer, stand at the opposite ('south') pole in 4-Dimensions on the 3D surface of the hypersphere, the light comes at me radially in 3D, shining in upon me from all directions.

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[a] Globe

[b] Glome, or 'hypersphere'

[c] *The Principle of Relationship:* Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

[d] Light left from every point in the universe, although the only one that concerns me as observer is the point from which I currently view light beams arriving. Of course the light also left from the point I now occupy, but I cannot now see that light because it is on the opposite 'side' of the hypersphere.

6) I do not see its singular origin at an antipodal 'north pole', I only see it coming at me from the equator. This is why I experience the CMB coming from every direction: it is converging on me from the universe's 2D equator through the 3D surface of the hypersphere. (We will come to this.)
7) As observer, I stand at the crossover (the 'south pole') and any light beams coming at me *from opposite sides* will criss-cross at me and head off in opposite directions.
8) In theory they are on a path which will eventually re-cross the universe's 2D equator.
9) Each light beam is now theoretically[a] heading back toward its 'north pole' origin from the opposite direction in 3D from which it left.

So we see that applying the 3D globe analogy to our 4D reality explains why relic radiation from the CMB approaches the observer equally from every direction in space, and yet displays *'extraordinarily uniform'* (Penrose[b]) smoothness and homogeneity. The analogy tells us this is because *it is all the same light*, in the sense that all the photons left from the same location at the same time in different directions. Each photon has traced its own great circle (which it experiences as a straight line) through the universe's 3-Dimensional surface to reach the observer.

Of course these are not poles in the Earth sense which pertain to an axis of spin. Instead they are observer's viewpoint-based *3D antipodes* which may be located anywhere, and which reveal a cross-section of the universe's 4-Dimensional shape and size. In light terms, this carries the highly significant implication that the observer is always located at a point which is polar opposite in 4-Dimensions to a 'point' at which the universe originated, defined as follows:

> *The observer's (spacetime event) location is an antipode on the 3-sphere surface to the origin of the observer's location within the Big Bang singularity.*

This geometry works as an explanation of the way relic radiation is observed by astronomers to behave, and is therefore strong evidence for a *Flatland*-style dimensional relationship between the observable universe (3D) and the universe proper (4D).

Conclusion

As all CMB radiation originates in the same location there is no longer a problem with superluminality. Without the need for any form of inflationary[c] 'burst' event or arbitrary fix, the globe analogy provides a straightforward explanation for:

1) The omni-directionality of the CMB, and
2) The smooth homogeneity of the CMB.

This – the (spacetime event of the) observer's location, and Big Bang singularity origin – located at antipodes of a 3-sphere slice of the 4D universe, is the most parsimonious solution to the problem of cosmic microwave-background uniformity, and corresponds to observation.

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[a] I say 'theoretically' heading back because it will be shown in Essay 7 that relic radiation may only ever travel a 'half-circumference'.
[b] Roger Penrose, *Cycles of Time*, Vintage 2011, P75
[c] Which is not to say that Inflationary theory does not have relation to other aspects of the Big Bang such as galaxy-seeding fluctuations or the matter/antimatter imbalance – only that it is not required to explain the uniformity of the CMB.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 5/15:

The observer-centric model of the universe: the 'rolling balls' experiment demonstrates how the finite 3-sphere appears to the observer

Abstract

The observable universe obeys *Flatland* dimensional principles, experienced by the observer as a single 3D spherical cross-section of the universe proper. This 3-sphere comprises 'northern' and 'southern' 3-hemispheres with Origin at *Centre A* and Observer at *Centre B*. Described by reference to the 'globe analogy', the 'rolling balls' experiment, and the 'Antarctica effect', the essay concludes with a diagram of the 'observer-centric model' of the observable universe, as experienced from one observer location.

Introduction

Following on from Essay 4 let us now consider, *'What shape does light actually render the observable universe as it follows a path in 4-Dimensions through northern and southern hemispheres?'* To answer this we must consider what goes on at the observable perimeter because *current models suggest* there should be other bubbles joined on to this one in such a way that original light from the same source has been able to set out in the opposite direction to my light, arriving at another 'observer' (let's call him Λllen the alien) who resides at the centre of his own observable universe with the CMB arriving at him from his perimeter. Λllen's bit of universe is filled with different starfield permutations and matter, but is in terms of the physics identical to mine. His bubble could overlap with mine or it could be far away, however, for his CMB and mine to have travelled the same distance from our perimeters, the two perimeters must 'touch' at one point.

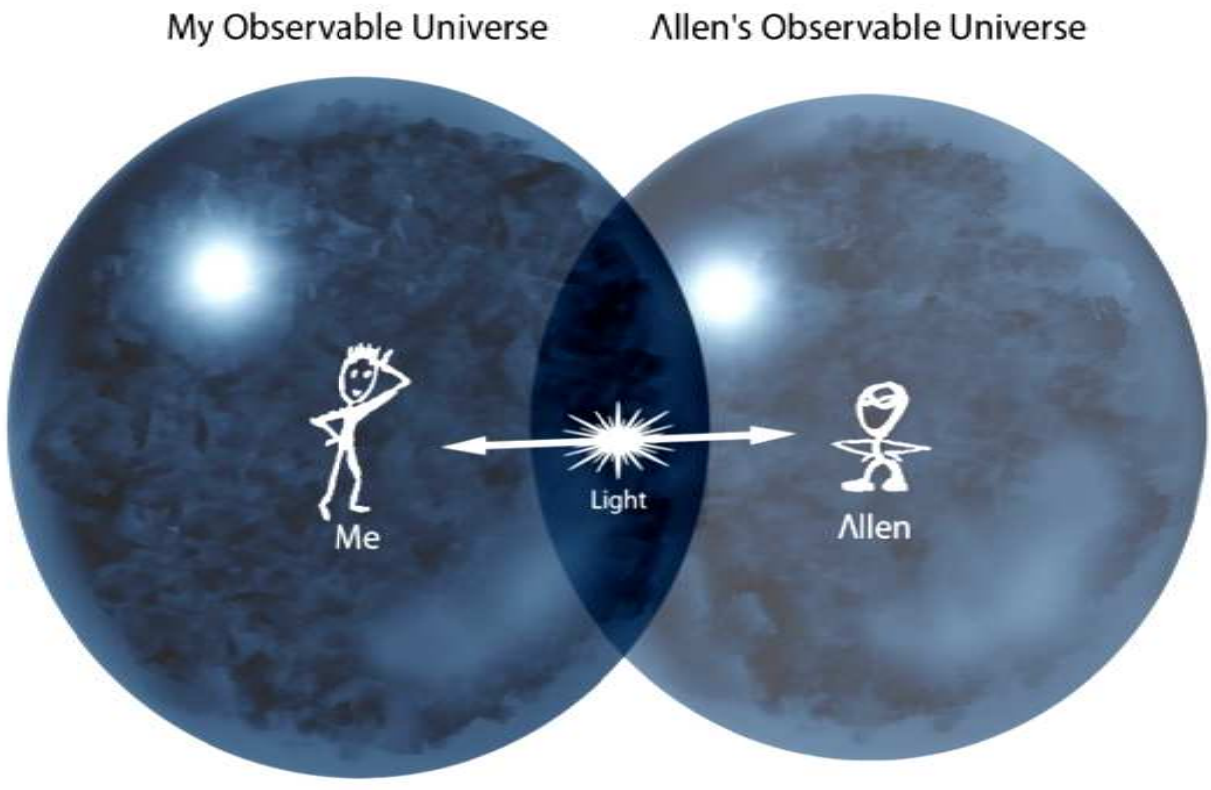

Fig.1 **The 'snooker ball' universe**. In this scenario Λllen resides as far away from me as it is physically possible to be whilst still viewing the same light, because he is twice the radius of the observable bubble away and (in theory at least) the light comes at us both looking like it started out midway between us.

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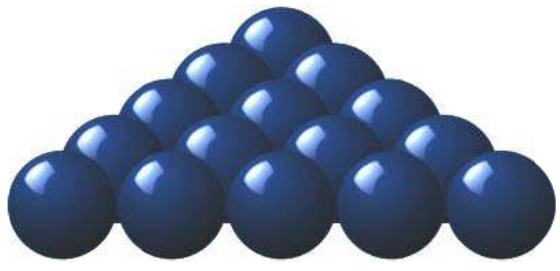
[a] This essay was abridged from Chapter 27, *The 2D Equator*, and Chapter 28, *The Observer-Centric Model*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

But what happens at the other side of my bubble – or the other side of Λllen's bubble? More bubbles? Here we have infinite observable universes stretching off into infinity. Science writer Marcus Chown explains that this is the natural consequence of the theory of Cosmic Inflation: *'So our observable universe is akin to a bubble and beyond it lies an infinite number of other bubbles that have a similarly restricted view."*[a]



However, in this 'snooker ball universe' spherical cross-sections are being permitted to behave in ways that conflict with the dimensional principles of *Flatland* – stacking up without fusing together in accordance with the *Principle of Character*[b]. What has happened? We have fallen into the trap of forming a 3D picture of a 4D entity. If the global universe has a 4-Dimensional 'shape' we must accept at the outset that it will be impossible to visualise. Instead we must focus on forming a true picture of one single 3D observable sphere that exists as a cross-section of the 4D hypersphere. To do this we will now model the action of the 2D equator which divides the observable 3-sphere (i.e. one 'snooker ball') into twin 3-hemispheres.

The rolling balls

Since, by extrapolation of the globe analogy in Essay 4, it is reasonable to posit that relic radiation has travelled an observer-based path from its origin, crossed an equator which is up by one dimension from Earth's linear equator, then converged on the observer from all directions, we must ask, *'Is it possible for us to recreate a 3-Dimensional model of the observable universe in which all of these conditions are satisfied?'* The behaviour of the 2-Dimensional equator may be modelled as follows:

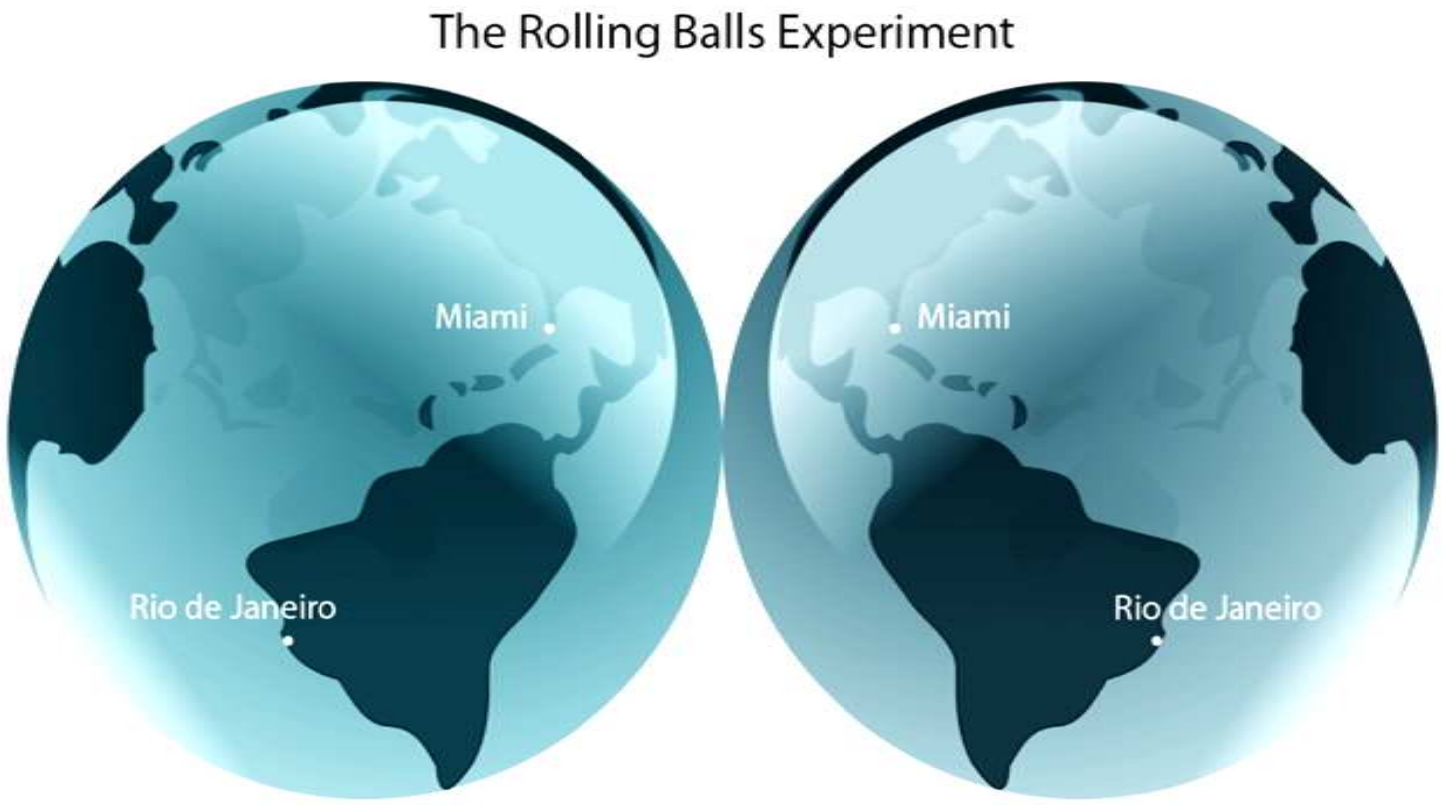


Fig.3 **The `rolling balls'**. Take a ball to act as the globe of the Earth, then a second ball the same size which is 'printed' as a mirror image of the first. Now we make them touch at a specific mirrored geographical location, say Miami. Lining up the eastern seaboard of the United States we then roll them around slowly and carefully against each other. The rolling balls will always make contact at the same places, Rio to Rio, Cape Town to Cape Town, Beijing to Beijing… and no matter how much we roll them we can always return to the twin Miamis.

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[a] New Scientist/The Collection, Vol 1 Issue 1, 2014, Marcus Chown, *Is there more than one of me?*, P29

[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.

But what if the surface of this second ball were somehow able to touch *at every same point simultaneously?* This is a beautiful symmetry which shows that it is mathematically feasible for bubbles to exist with their surfaces touching at every same point. This is possible because equivalent locations on the two surfaces are, at the instant they touch, the same location. A crude way to visualise this is to imagine the second ball turned inside out over the surface of the first ball. However, we must allow them to retain the property that *each globe still exists intact at each side of the surface.* This would mean that a straight line can be traced in any radial direction from the centre of globe A to the centre of globe B, or vice versa. To view this line in action we must roll the balls because it passes through the mid-point at which they touch, however, in the 4th Dimension no rolling is required because the globe surfaces touch simultaneously at every same point.

Now, imagine you are inside one of the balls, at its centre. *Any direction you look you will view a straight line that leads to the centre of the other ball*. The second ball appears distorted. You set off to walk toward it. Suddenly as you cross their shared surface you enter the second ball which materialises intact before you, and you carry on to its centre. Looking back, you see that it is your starting point that is all around you, distorted. In summary:

- A second bubble exists on the other side of *any point* at which we leave our own bubble.
- The two bubble-centres (we will designate them *Centre A* and *Centre B*) are joined by a straight line which runs through every 'same point' (Miami to Miami) on the perimeter.
- We now have two 3D spheres with the same 2D surface.
- This shared spherical surface acts as a *2-Dimensional equator* between the spheres, joining them in precisely the same way that the Earth's *1-Dimensional equator* acts as a 'join' for the northern and southern hemispheres.
- The twin spheres are northern and southern '3-hemispheres', or hemi-balls, which divide the surface of the 4-Dimensional universe in half. To distinguish them from our accustomed Earth-style hemispheres I will use the historically redundant term, 'demispheres'.

The CMB projection

I mentioned above that the neighbouring demisphere will appear 'distorted'. In actual fact, everything beyond the 2D equator will appear lensed. The effect of this lensing will be to magnify over distance until the centre of the northern demisphere (*Centre A*) fills the observer's vision. Viewed from *Centre B*, *Centre A* will appear projected spherically around the sky in a similar way to a map projection of the Earth's surface onto a flat page which causes Antarctica to appear (as per *Fig.4*) the widest landmass on Earth...

Antarctica

Antarctica according to
the Mercator Projection

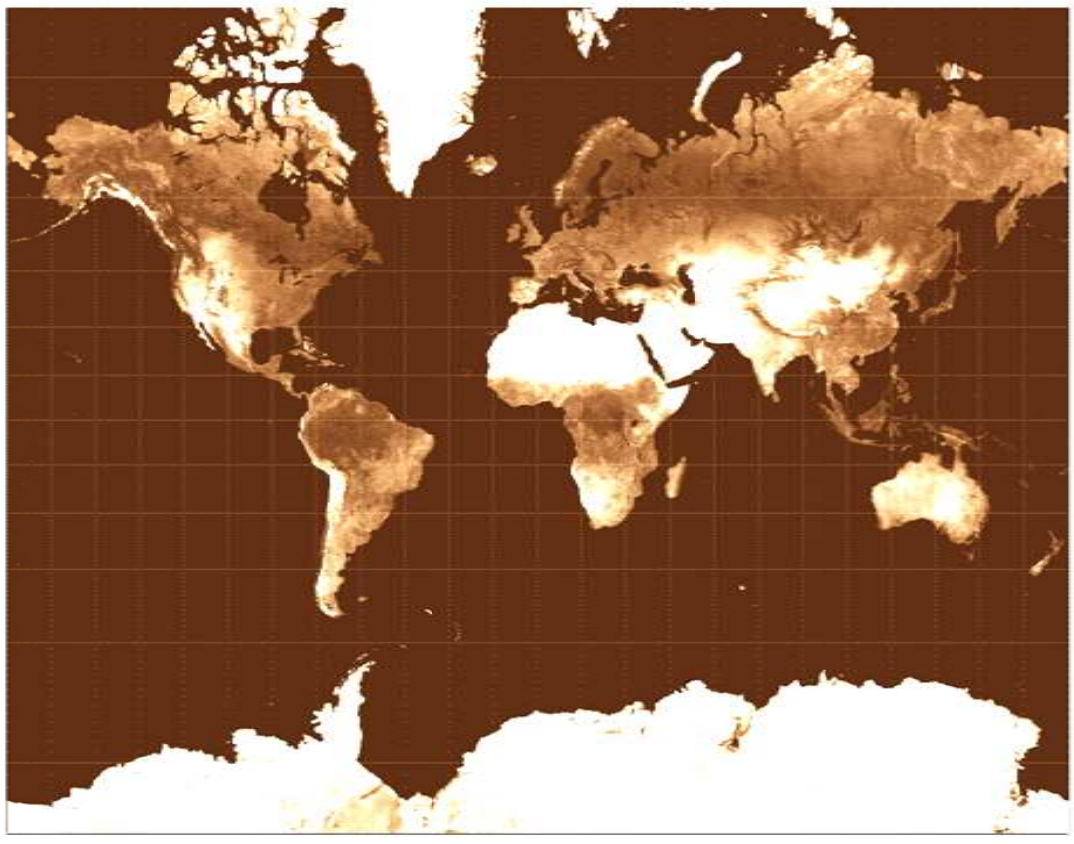

Fig.4 **The 'Antarctica effect'**. To facilitate exploration, Gerardus Mercator in 1569 rendered the spherical surface of the Earth on a flat sheet of paper, representing sailing courses of constant bearing as straight lines. His lines of longitude no longer converge at the poles but instead run parallel down the map, causing the northern and southern extremities to appear increasingly wider than they are. The 'dot' at the pole (to left) fills the whole width of the map (to right). Note that South America and Australia remain roughly the same size.

This is what gives us the impression that the CMB is coming at us from every direction in space: *Centre A* appears from *Centre B*[a] to be coated evenly over what appears to be the inner surface of a sphere, at a distance equal to the combined radii of the two demispheres. If, as per the globe analogy, we name the light's origin *Centre A* and the observer's location *Centre B*, relic radiation crosses the 2D equator isotropically[b] and converges on the observer radially in 3D. As described in Essay 4 this is in keeping with observation of the CMB, which converges on the observer spherically in 3D from all (diametrically opposite) sides of the sky. However it does not require the 'arbitrary fix' of Inflation to explain its uniformity, as it is all the same light, released at the same time from the same source[c].

The observer-centric model

Returning to the globe analogy where we thought of light beams as travelling away from the north pole and heading for the south pole along 1D lines of longitude, it should now be possible to derive an observer-based shape for the observable universe. To fully appreciate the role of the equator, let's begin by separating the northern and southern hemispheres of the Earth.

As before, we will write down and extrapolate a basic set of statements about these hemispheres which we hold to be true:

[a] And theoretically vice versa, although, because the phenomenon is observer-centric the observer must always occupy *Centre B*.
[b] Because it was emitted homogeneously at the 'surface of last scattering'.
[c] Uniformly throughout space close to the Big Bang.

	1D equator on 2D surface of 3D Globe:	*2D equator on 3D surface of 4D Glome:*
1)	The shape of each hemisphere is the same.	The shape of each demisphere is the same.
2)	They meet each other at their widest point, the 1D rim.	They meet each other at their widest point, the 2D surface.
3)	The two hemispheres share the same rim which comprises their 1D equator.	The twin demispheres share the same surface which comprises their 2D equator.
4)	Points on the rim/1D equator may be made to touch because they are actually the same point.	Points on the surface/2D equator may be made to touch because they are actually the same point.
5)	When joined, the 1D equator has no special significance on the sphere except as defined by the polar antipodes.	When joined, the 2D equator has no special significance on the hypersphere except as defined by the twin centres, located at 3D 'polar' antipodes.
6)	Antipodal points could be located anywhere on the surface of the sphere.	Antipodal points could be located anywhere on the surface of the hypersphere.

In *Elementary Topology: A Combinatorial and Algebraic Approach*[a], Donald W Blackett discusses the relationship between the northern and southern halves of the hypersphere, stating that *'the points on the equatorial sphere are left fixed'*. By 'fixed' he means Miami to Miami etc as per the 'rolling balls' experiment wherein each point on the 2D equator has the same relationship to each sphere – performing the 4-Dimensional 'trick' of joining the equatorial surfaces simultaneously at every point.

These twin spheres comprise the northern and southern demispheres which divide the *3-Dimensional* surface of our *4-Dimensional* universe. *Fig.6* (following page) shows the actual shape of the observable universe as experienced by one observer located at *Centre B*. (As the model is observer-centric the observer must always occupy a *Centre B*, which may correspond to any spacetime event.) Although the diagram shows the twin demispheres in contact at only one point, they are actually in contact *at every point simultaneously* on their shared spherical surface. This surface is the 2-Dimensional equator of our 3-sphere observable universe and is located at a look-back distance of half the radius of the observable universe. The observer's antipodal point of origin at *Centre A* appears (to the observer) projected across the surface of the observable universe from which the earliest light in the universe – the cosmic microwave-background radiation – is constantly arriving.

Conclusion

The observer-centric model describes the observable universe as a 3-sphere, one observer's experience of the surface of a 4-ball, consisting of northern and southern 3-hemispheres with origin and observer located at opposite poles (antipodes) [b]. Because the observable universe is experienced by the observer as a 3D spherical cross-section of the 4D hypersphere, the total of all spacetime event-centred spheres – i.e. *Centre*

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[a] Donald W Blackett, *Elementary Topology: A Combinatorial and Algebraic Approach*, Academic Press 1982, P198

[b] Considered spherically with origin and observer located at antipodes (rather than thought of as a widening disk) this is analogous to the Flatlander's/Spacelander's/Hyperlander's experience as described in Essay 2, such that the observer's experience always corresponds to a single (*Centre B* antipodal) location on the *n*-sphere surface of an (*n*+1)ball global universe. Thus the shape of the observable universe as experienced from each observer location corresponds to the magic treadmill mechanism which governs the observer's experience of temporality. In this way, rather than originating by speculation or arbitrary hypothesis, the observer-centric model is shown to be consistent with (because derived from) the principles of *Flatland*.

B-centred 'observable universes' – constitutes the fully stacked and completed 4th Dimension or block universe, in accordance with our *Flatland*-derived *Principle of Character*[a].

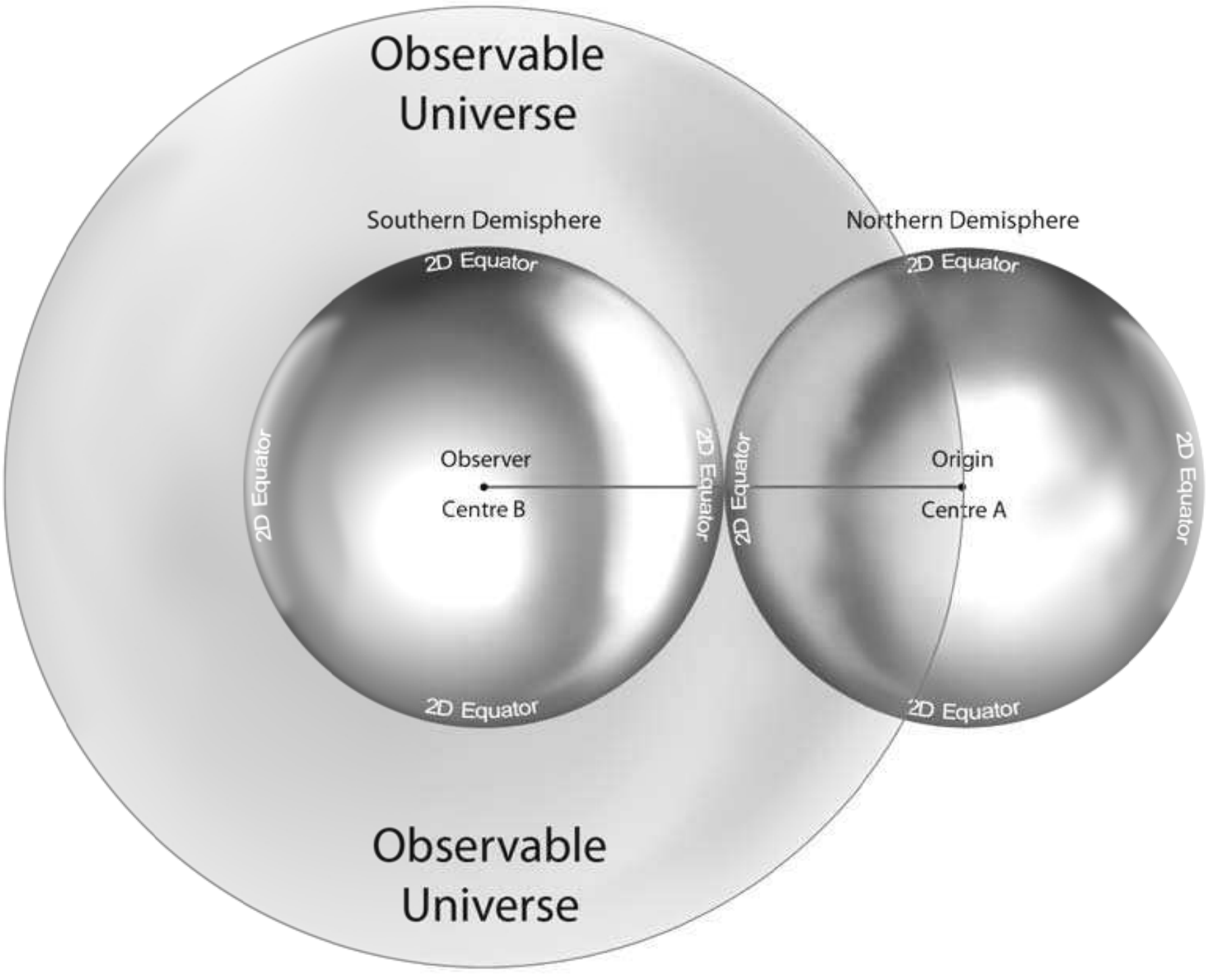

Fig.6 **The observer-centric model of the universe**. In the illustration, with the demisphere surfaces in full contact at every corresponding point, the lines that radiate away from and into each demisphere connect *Centres A* and *B*. The outer circle represents the distance of *Centre A* from *Centre B*, as viewed by the observer spherically in every direction by the 'Antarctica effect'.[b]

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[a] *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.

[b] The lines that radiate to join *Centre A* to *Centre B* correspond to the lines of longitude on the Earth, joining the poles. Imagining each demisphere filled with onion skin layers, these surfaces are the 2D analogue of the 1D lines of latitude around the Earth.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 6/15:

The observer-centric model is the spherical universe of Einstein, with (the addition of) origin and observer located at (polar) antipodes: *Centre A* and *Centre B*

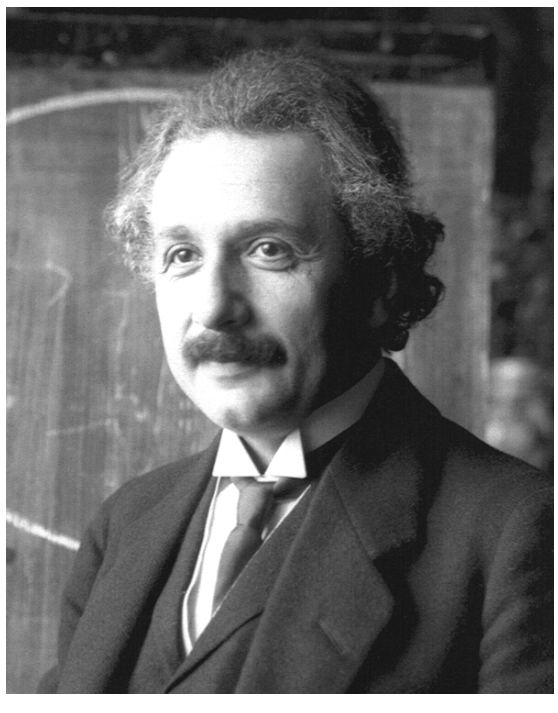
Abstract

By reference to Einstein's own writings the observer-centric model is shown to be the same as his favoured finite model based on sphericality; with the difference that origin and observer are located at (polar) antipodes of the 3-sphere, referred to respectively as *Centre A* and *Centre B*.

Background

Albert Einstein was concerned that the theory of Relativity, completed in 1915, should not remain the exclusive preserve of mathematicians and physicists. To this end he took some time the following year to write out a version containing minimal mathematics, but nonetheless explicating the full theory in his clear and thorough style. This book, from which I will quote in this chapter, is still in print and is titled simply, *Relativity*[b].

Parts I and II explicate Special and General Relativity. Here we will look at Part III (comprising the final three Sections, 30, 31, 32) which he titled *Considerations on the Universe as a Whole*.



Albert Einstein, 1879-1955

The importance of being equivalent

Near the end of Section 31, Einstein states that Relativity presents us with only two options for the universe's shape:

1) *'infinite'*, or
2) *'finite in the manner of the spherical universe'*

Adding that, in 1916, *'Our experience is far from being sufficient to enable us to answer this question.'* However, he framed the question and addressed it to generations of astronomers and physicists to come, expecting that one day sufficient observational data would be in to furnish an answer. Three decades later, by which time considerably more data was in, he was if anything in more of a mind to leave the question

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[a] This essay was abridged from Chapter 29, *Einstein's Alternative to the Multiverse*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Albert Einstein, *Relativity* (1916), Routledge 2001

open[a]. Today, an infinite universe is widely accepted and Einstein's *Option 1* is now the Standard Model of modern cosmology. However, in the concluding sentence he draws our attention to the idea that the principles of Relativity indicate that this two-horse race has a favourite, and, for Einstein, it is *not* the Standard Model: *'But the general theory of relativity permits of our answering it with a moderate degree of certainty, and in this connection the difficulty mentioned in Section 30 finds its solution.'*

What precisely is this *'difficulty mentioned in Section 30"*? It can be summed up in one word: 'arbitrariness'. Discussing Newton's law he concluded his earlier Section 30 as follows: *'...we purchase our emancipation... at the cost of a modification... which has neither empirical nor theoretical foundation. We can imagine innumerable laws which would serve the same purpose, without our being able to state a reason why one of them is to be preferred to the others;'*

Nicolas Copernicus said something similar about the 'standard model' of his day, the Ptolemaic system: *'It is as though an artist were to gather the hands, feet, head... from diverse models, each part excellently drawn, but not related to a single body, and since they in no way match each other, the result would be monster rather than man.'* Like Copernicus, Einstein is no fan of arbitrariness. He sees it as the likely indicator of a fatally flawed model, and in Section 31 identifies this as the difficulty with *Option 1*, the infinite and unbounded ('snooker ball') universe. Having earlier described a 3-Dimensionally spherical space by reference to Flatlanders, he concludes regarding *Option 2*: *'It follows from what has been said, that closed spaces without limits are conceivable. From amongst these, the spherical space (and the elliptical) excels in its simplicity, since all points on it are equivalent.'*

Not for the first time Einstein shows his appreciation of equivalence. This spherically finite yet unbounded space, for all the reasons he gives, is the universe he prefers.

2D space

So how does Einstein describe this spherical space? Without the distraction of naming *Flatland* in such a seminal document he begins: *'In the first place, we imagine an existence in two-dimensional space. Flat beings... are free to move in a plane. For them nothing exists outside of this plane: that which they observe to happen to themselves and to their flat "things" is the all-inclusive reality of their plane.'* After explaining how their 2D world is infinite and Euclidean geometry applies, he continues: *'Let us consider now a second two-dimensional existence, but this time on a spherical surface instead of on a plane.' 'Their whole universe of observation extends exclusively over the surface of the sphere.'* After explaining that their straight line has become a geodesic he writes: *'The great charm resulting from this consideration lies in the recognition of the fact that the universe of these beings is finite and yet has no limits.'* He now derives circles of latitude: *'Starting from a point, they draw "straight lines" (arcs...) of equal length in all directions. They will call the line joining the free ends of these lines a "circle".'* The 'free ends' of these lines of longitude define circles of latitude; these then grow until they reach (i.e. become) the equator, then

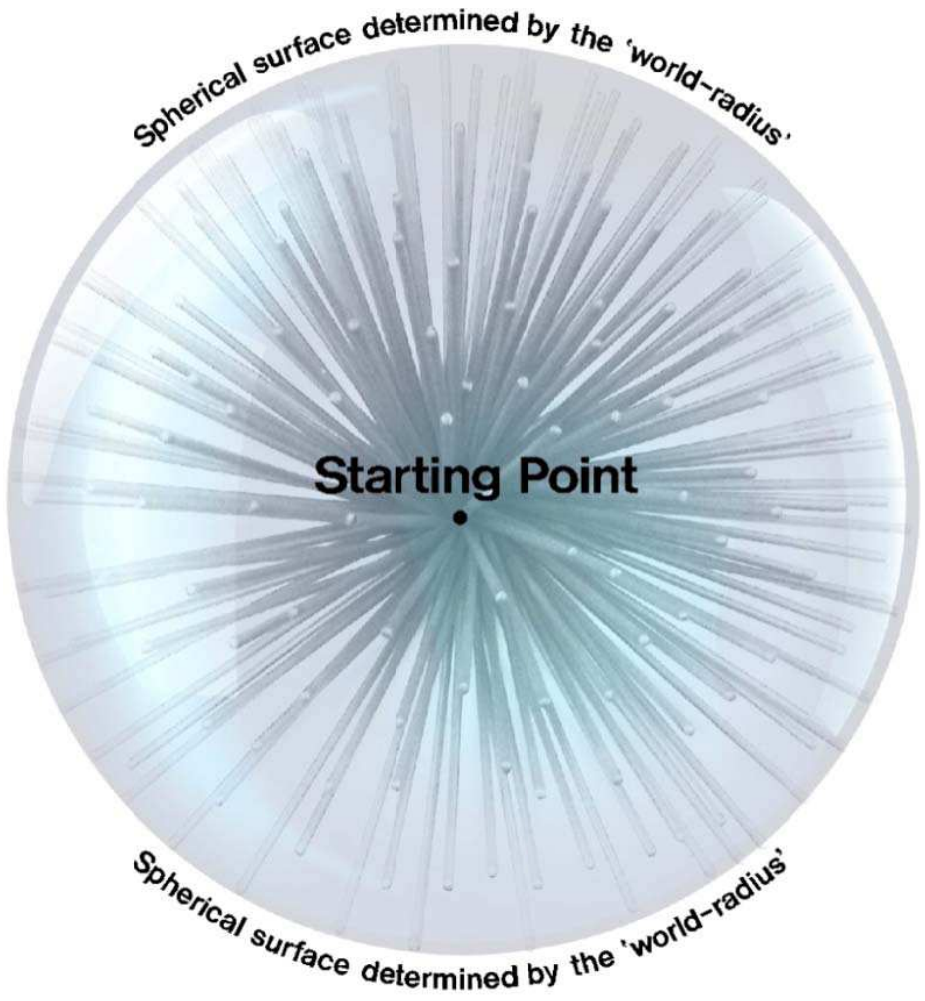
[a] Albert Einstein, *Relativity, Appendix 4*, Routledge 2001. The mid/late 1940s were a time of great uncertainty in the cosmological world, with debate at its height between Hermann Bondi and George Gamow over the Steady State/Big Bang enigma (it wasn't until 1964 that the question was settled with the discovery of the cosmic microwave-background radiation). One gets the feeling that Einstein, now 67, felt the need to stress that his classic theory did not take sides.

reduce as they approach the opposite pole. Einstein has now set the scene for the extrapolation he is about to make from 2 to 3-Dimensions.

3D space

Here Einstein casts the mould for mathematicians and physicists to come, deploying dimensional analogy on the grounds that: *'It is easily seen that the three-dimensional spherical space is quite analogous to the two-dimensional spherical surface. It is finite (i.e. of finite volume), and has no bounds."*[a] Modern day topologists postulate many possible shapes for a 3-Dimensional surface of space, but Einstein pre-empts their gratuitous over-sophistication: *'Perhaps the reader will wonder why we have placed our "beings" on a sphere rather than on another closed surface.''...of all closed surfaces, the sphere is unique in possessing the property that all points on it are equivalent.' 'To this two-dimensional sphere-universe there is a three-dimensional analogy, namely, the three-dimensional spherical space which was discovered by Riemann. Its points are likewise all equivalent.'*

Here we see why Einstein advocates sphericality as the only realistic alternative to infinity: it is because *any other shape demands a reason for its irregularity*. In the absence of this, the equivalence of all points must be accepted as an axiom. Einstein now asks: *'Is it possible to imagine a spherical space? To imagine a space means nothing else than that we imagine an epitome of our "space" experience... In this sense we <u>can</u> imagine a spherical space.'* In other words, we are all living in it.



Now, having described the simplicity of the curved 2D surface of a 3D sphere, he shifts this up by one dimension to the 3D surface of a 4D hypersphere (the 3-sphere surface of a 4-ball) by deriving the extrapolated analogue of the 'lines of longitude/circles of latitude' described above: *'Suppose we draw lines or stretch strings in all directions from a point, and mark off from each of these the distance **r** with a measuring-rod. All the free endpoints of these lengths lie on a spherical surface.'* Here we may think of Einstein's 'point' as the location of the observer. Lines radiate away from this point to a certain radius, *r*. The observer is now surrounded in every direction by a sphere of radius *r*. By means of calculations of area he now begins to explain the way that this 3D space behaves: *'If the universe is Euclidean, then $F=4\pi r^2$; if it is spherical, then F is always less than $4\pi r^2$. With increasing values of r, F increases from zero up to a maximum value which is determined by the "world-radius," but for still further increasing values of r, the area gradually diminishes to zero. We can specially measure up the area (F) of this surface by means of a square made up of*

[a] Note that Einstein's (translator's) use of the word 'quite' would be in the old sense of 'exactly', rather than the modern sense of 'roughly'. I suspect that rough analogies would have been of little use to him.

measuring-rods.' But something curious happens as the radius continues to increase: *'At first, the straight lines which radiate from the starting point diverge farther and farther from one another, but later they approach each other, and finally they run together again at a "counter-point" to the starting point.'*

To simplify let's take just two of these lines; they diverge from one another until they hit the surface of the observer's encompassing sphere which Einstein terms the *'world-radius'*, then they converge to a counter-point:

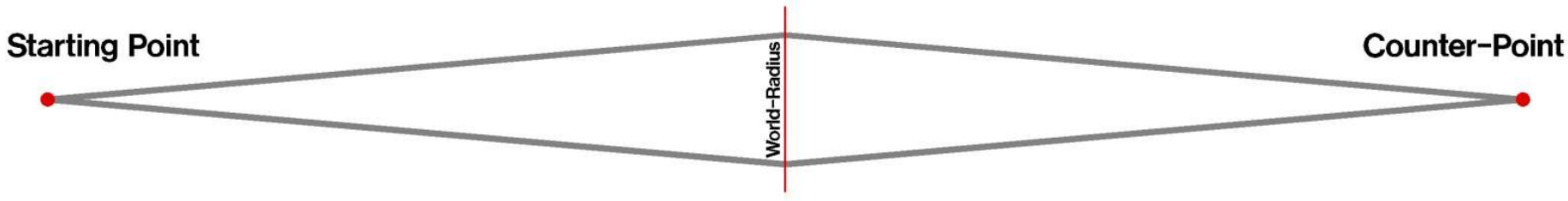


Fig.3 Lines leave the starting point, diverge, pass through the world radius, then converge on the counter-point.

However, although all the lines radiate then converge, they do not bend in the middle as per our limited 3D conceptualisation in *Fig.3*. Instead each line is straight all along its journey as per *Fig.4*:

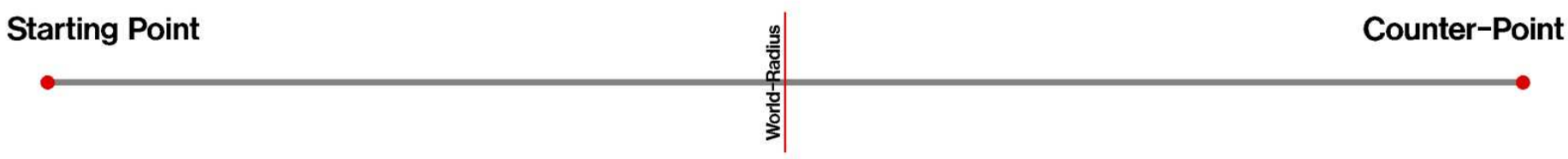


Fig.4 Each of these lines is straight all along its course.

Repeat this action for every line that radiates away from the observer and we have the situation where they all hit the spherical surface of the 'world radius' then converge to a 'counter-point' at the centre of a second sphere; this 'counter-sphere' shares the same surface as the first at the 'world-radius'. (Of course it is impossible to draw *accurately* this shared surface because it is viewed as the surface of a sphere from both sides (i.e. from both Einstein's 'starting point' and his 'counter-point'.) *'Under such conditions they [the lines] have traversed the whole spherical space.'*

These two spheres together constitute the whole space because to exit one at any point is to enter the other, and vice versa. However, it is significant that each line connecting the two centre points passes *straight* through 3-Dimensional space between the starting and counter-points. All curvature takes place into the 4th Dimension. Within the observer's own (3-hemi)sphere all angles and parallel lines will therefore appear to the observer Euclidean, becoming non-Euclidean with respect to each other only as they traverse the 'world-radius'.

Comparison with the observer-centric model

Einstein's *'starting point'* corresponds to the location of the observer at *Centre B* whilst his *'counter-point'* corresponds to the origin at *Centre A*. The shared surface of the two spheres which Einstein calls the *'world radius'* corresponds to the 2-Dimensional equator which joins the twin demispheres (3-hemispheres), with each acting as a 3-Dimensional northern or southern demisphere.

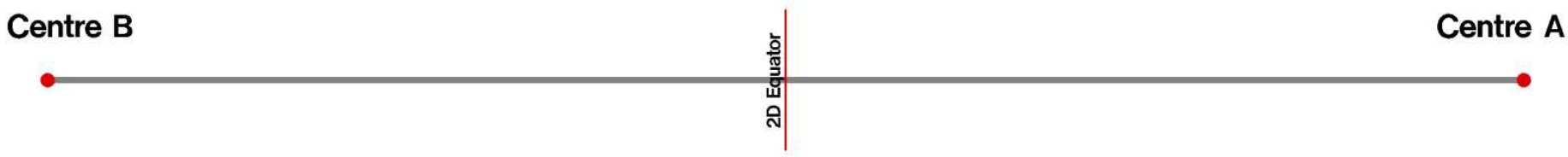


Fig.5 Here, Einstein's terminology from *Fig.4* is replaced by the terminology of the observer-centric model, being mathematically the same.

Einstein's challenge

As we continue reading through Section 31, Einstein confirms the integrity of dimensional analogy and extrapolation as a means of investigating the universe of which we are a part: *'It is easily seen that the three-dimensional spherical space is quite analogous to the two-dimensional spherical surface. It is finite (i.e. of finite volume), and has no bounds.'*

But what Albert Einstein does not do is tell us for sure that the universe is this shape. Why? Because it was 1916, and with the words *'Our experience is far from being sufficient'* he acknowledges the need for more empirical data. He commits the situation to the professionals: *'As a result of this discussion, a most interesting question arises for astronomers and physicists, and that is whether the universe in which we live is infinite, or whether it is finite in the manner of the spherical universe.'* For him it is one or the other, but the great man knows in his heart of hearts that the question is not likely to be resolved in his day.

A century on

When consulted, Einstein's scientific contemporaries assured him in the strongest possible terms that the universe is static. They were correct, in that the Milky Way was for them the known universe. Within a decade the work of Edwin Hubble – based on the data of Vesto Slipher who is credited with the discovery of redshift – showed that the universe is expanding. As the 20th Century progressed and the larger the universe grew, the surer we became that it must be infinite, culminating in the hotly debated 'four level' multiverse of today. Science writer Christopher Potter reflects: *'For a while, the more we found out about the physical universe the larger it became. But largeness itself has become **passé**. The universe shows itself to be subtler than mere size.'*[a] [*Emphasis his*] It is not the universe's size that matters but its shape. A fuller understanding of its shape will reveal why it is the size it is.

Conclusion

Einstein's account of a spherically finite universe is geometrically identical to the observer-centric model. His counter-points correspond to *Centre A* and *Centre B*, whilst his use of the term *'world-radius'* corresponds to the shared spherical surface of the 2-Dimensional equator. Einstein also confirms that the lines joining his counter-points are *'straight lines'* and that they have *'traversed the whole space'*. The observer-centric model differs from Einstein's model only in that the observer is located in the 'southern demisphere' at *Centre B* ('starting point') whilst the origin is located in the 'northern demisphere' at *Centre A* ('counter-point').

[a] Christopher Potter, *How to Make a Human Being*, Fourth Estate 2014, P21

What Einstein did not propose[a] was that beyond the 2D equator (his *'world-radius'*) the observer's view of the northern demisphere would become lensed by dimensional projection, with maximum distance (the origin at *Centre A*) spread across the surface of the observable universe by the 'Antarctica effect', as evidenced by the homogeneity of the cosmic microwave-background radiation.

[a] Due to insufficiency of empirical data.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 7/15:

Light cannot circumnavigate the 3-sphere universe, as relic radiation has always travelled a half-circumference with respect to the observer

Abstract

Oxford mathematician Roger Penrose observed that: *'It is a striking fact that **all** the established departures from the Newtonian picture have been, in some fundamental way, associated with the behaviour of **light**.'*[b] [*Emphasis his*] The observer-centric model must necessarily do the same. Observer-centricity within the model points to *Centre A/B* recession at *c*, the half-circumference journey of light, and other phenomena which occur in keeping with Special Relativity.

Causally connected

Professor of Theoretical Physics at Berkeley, Raphael Bousso maintains that physicists are working hard right now to eliminate the problem of infinities. He describes how his own research was initially inspired by the idea that *'...we shouldn't think of the universe as existing on this global scale that no one observer can actually see ...it's actually important to think about what can happen in the causally connected region to one observer.'*[c] The observer-centric model not only dispenses with infinity's cosmic horizon but thrusts the observer to centre stage in an observer-centric universe that is one single, finite, causally connected region.

Looking into space in any direction we detect the light of the cosmic microwave-background radiation (CMB). Relic radiation which arrives at us has travelled a straight path through spacetime from its everywhere-origin close to *Centre A* and we are viewing it as it was when it left that origin[d]. Having traversed the northern demisphere and crossed the 2D equator, it has travelled through the southern demisphere to converge on the observer located at *Centre B*.

Since *Centre A* is the source of all events that can ever possibly reach the observer from or since our Big Bang origin, it represents the maximum distance that anything in the universe may be from me; which is the same as to say that, at any given moment, it is *the maximum possible distance between two points.* This carries the inference that the universe is a compact system in 3D – a closed universe that each and every observer, no matter where in the global universe they may be located, can look out and view in its entirety, providing a simple and reasonable alternative to the infinite 'snooker ball'[e] universe, or runaway notions of a multiverse.

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[a] This essay was abridged from Chapter 30, *The Half-Circumference of Light*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Roger Penrose, *The Emperor's New Mind*, Oxford 1989 (Revised 2016), P285

[c] Raphael Bousso, *Thinking About the Universe on the Larger Scales*, from *The Universe*, Edited by John Brockman, Harper Perennial 2014, P301

[d] Barring incidents such as gravitational lensing and the Shapiro delay effect. Also the Earth's frame of reference is in fact co-moving in relation to the CMB. This (in the grand scheme of things) very slight effect has built up over 13.8 billion years and is consistent with the fact that the CMB is not *Centre A* as such. Correcting for this would place the observer in the nearest thing possible to a 'stationary' frame of reference as the CMB is the largest cosmic object in the universe.

[e] See Essay 5

This is true because light from the Big Bang cannot have 'headed off in the opposite direction' to reach an observer whose location lies beyond our observable horizon because, on reaching the 2D equator the light enters my demisphere at that point, radiating in toward me from behind[a] (see the 'rolling balls' experiment, Essay 5). The *Wikipedia* article on the game *Asteroids* describes this effect as *'a two-dimensional view that wraps around in both screen axes'*[b]. Known to science as the Pac-Man universe, if we shift this up by one dimension light traverses the 3-sphere surface of the 4-ball such that, just as an airliner flying from London to Los Angeles will follow a line which is straight in 2-Dimensions but curves into the 3rd, light sets off through the 3D universe in a line which is straight in 3-Dimensions but which 'curves' into a 4th Dimension.

Cosmologists have for a long time recognised the Pac-Man universe as a potential solution. Here it is described by Werner Heisenberg in 1958: *'It may be that the space filled by the universe is finite. This would not mean that there is an end of the universe at some place. It would only mean that by proceeding farther and farther in one direction in the universe one would finally come back to the point from which one had started. The situation would be similar as in the two-dimensional geometry on the surface of the earth where we, when starting from a point in an eastward direction, finally come back to this point from the west.'*[c]

By locating the origin at *Centre A* and the observer at *Centre B* – derived over the course of these essays by extrapolation of the Linelander's, Flatlander's and Spacelander's perception – the observer-centric model describes a practical 3D mechanism for this phenomenon.

Circumnavigation

The idea that light may have circumnavigated the universe, perhaps several times, has been researched by topologists both mathematically and observationally[d]. The distance photons would be able to cover – and therefore the number of times they would be able to go round a 'hall of mirrors' universe – is currently thought only to be limited by the size of that universe. Neil Cornish, an astrophysicist at Montana State University, puts it thus: *"If the universe was finite, and had a size of about 4 billion to 5 billion light-years, then light would be able to wrap around the universe, and with a big enough telescope we could view the Earth just after it solidified..."*[e]

This is based on the conventional view that the universe out there exists as a physically objective space which light may explore as a 'free-roving entity'. However, in this *Flatland*-derived dimensional paradigm light is not a 'thing in the universe', but is instead integral to its form and structural unfolding[f]. Understood dimensionally, the 'speed limit of the universe' has less to do with light itself and more to do with Einstein's description of the universe as a *'four dimensional continuum'*[g]. This has serious implications which we are about to examine.

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[a] Light's path through the universe will be traced in more detail in Essays 9 and 10.
[b] https://en.wikipedia.org/wiki/Asteroids_(video_game) - Accessed 22nd Mar 2017
[c] Werner Heisenberg, *Physics and Philosophy*, Penguin Classics 2000, (original copyright 1958), P79
[d] https://arxiv.org/abs/astro-ph/0310233v1
[e] http://edition.cnn.com/2004/TECH/space/05/24/universe.wide - Accessed 17th Nov 2015
[f] The role of light within an all-inclusive 4-Dimensional framework is discussed more fully in Section 3, *Dimensional Structure*, of the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X
[g] Albert Einstein, *Relativity, Appendix 5*, Routledge 2001, P151

The half-circumference of light

Einstein changed the world by imagining that he was able ride with the photon – in the same spirit let us now visualise the little photon of light's post-Big Bang journey through the observer-centric model:

- The primeval photon sets off from its point of origin near *Centre A*, travels in a straight line along the shortest path available to it around and between all the local lumps and bumps of spacetime through the northern demisphere, crosses the 2D equator (Einstein's 'world-radius', where the twin demispheres touch at all 'same' points) and continues in a straight line into the southern demisphere, passing through the observer's location at *Centre B* – the origin's antipode – after which, theoretically, it should re-cross the 2D equator, returning into the northern demisphere at its opposite side to pass straight through its point of origin at *Centre A*. It then sets off again…

But what *actually* happens to the light as it passes me as observer – does it really set forth on the long journey back? Or will it simply be lost in the void – stretched by expansion, cooled by time, sniped by collisions, vandalised by ionisation and deflected by gravitational lensing on its quest to re-cross the equator? No. It will do none of these, because the whole path is observer-dependent. *For the photon* there is no 'path', no 'equator', and no 'return to the origin'. All that photons are actually doing is being observed whilst existing at the speed of light[a]. It is central to the model that, whilst the demispheres accurately describe the path that relic light has taken, ***that path may only be described retrospectively by the observer***.

There is nothing special about the photon's trans-equatorial adventure which it retains and is somehow able to impart to us, because the whole trip is only a description of the light's journey *from the observer's viewpoint*. The light itself did not cross any actual, fixed backdrop-style 'equator' any more than it is crossing an equator now. It may only be *viewed* as having taken *that* path by *that* observer.

Crucially, we must bear in mind that the photon is also an 'observer' and occupies its own *Centre B*. And because the photon recedes from its (CMB) point of origin at *c*, this tells us that *all observers are receding relativistically from their origin at Centre A*. The relationship between observer and origin throughout the universe must therefore be reckoned in terms of Relativity. The retrospectively viewed path described above will expand as the distance between observer and origin increases relativistically at *c*. I will refer to this as *Centre A/B* recession at *c*, which occurs in keeping with Special Relativity[b].

Clearly the path of light through the universe may only be described in terms of what goes on between origin at *Centre A* and observer at *Centre B*. Every point on the photon's journey, past or future, might equally be considered a *Centre B* by any observer located there, therefore, ***the path of light as viewed by any observer at any location comprises only the first half of the hypersphere's polar circumference***.

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[a] Relativity tells us that from the photon's viewpoint as a massless particle travelling at the speed of light the universe is completely length contracted, therefore its origin and its destination are the same. The photon's path – and therefore the universe as we view it – is not objective, but wholly observer-dependent.

[b] General Relativity will be discussed in Essay 14.

Since this mathematical relationship does not change over time, the universe has held this shape throughout its emergence from the Big Bang singularity. A direct link therefore exists between the *Centre A/B* half-circumference and the phenomenon of the universe's expansion, with expansion occuring as an aspect of the relativistic experience of each (massive) observer's relationship at *Centre B* with origin at *Centre A*.
[See Essay 8]

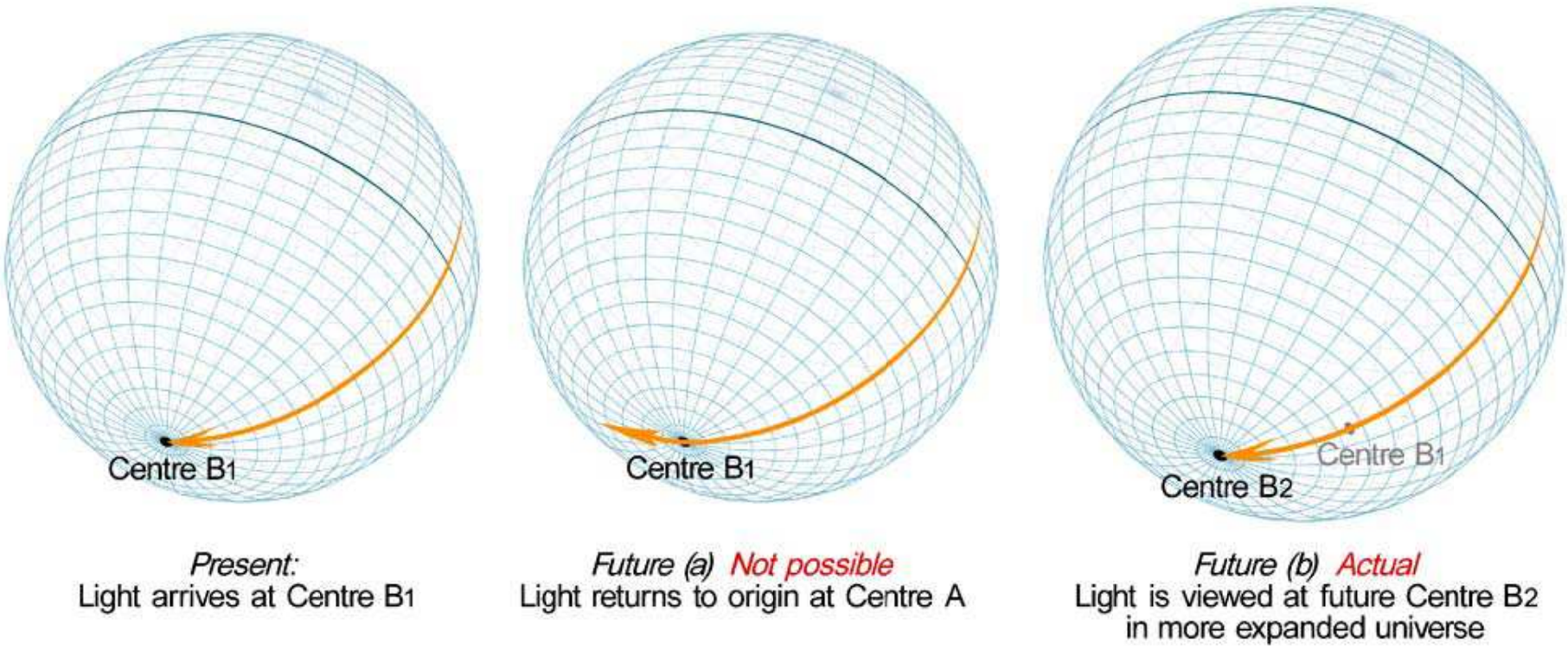

Fig.2 Taking the analogue down by one dimension, these three spheres demonstrate why it is not possible for relic radiation to circumnavigate the universe. The photon always exists at an observer location, a *Centre B*, which corresponds to an antipode of *Centre A*. In this way – as illustrated in *Future (b)* – all observers at *Centre B* view the photon's history as having covered a half-circumference of the observable universe.

Although it is true that light converges on the observer from all directions and continues on its way, it cannot in fact 'head back' toward the origin or circumnavigate. Every point on the light's journey is an observer-location at *Centre B*, therefore future radiation from the CMB must also converge on future *Centre B's*. Although light is following the geodesic across (or as we experience it, through) the 3D surface of the hypersphere, it can never complete a round trip because, no matter where in the universe the light starts off, the *definition* of its path ends at the observer at *Centre B* in the moment now.

Of course the light continues on past the observer into the future at the speed of light, but it has no more 'universe-defining' relevance to the first observer's experience at *Centre B1*. When the same light is viewed by another observer at *Centre B2*, she will experience it within her own *Centre B* experience in her moment now in the same way as the first observer: coming at her in a straight line from her past – a direction that is *always* in line of sight to the origin at *Centre A*, and *always* bisected by her experience of the 2D equator.

Strong complementarity

Clearly a dimensional understanding of the universe's physical shape places the observer firmly in the driving seat, and – as discussed in Essay 3 – to think of the observable universe as 'centred on the Earth' is far too woolly an approximation.

Science writer Amanda Gefter encapsulates this, describing the experience of each observer as having his or her 'own universe'. Discussing recently uncovered problems associated with black holes she writes[a]: *'Physicists are beginning to think that the best solution to the firewall paradox may be to adopt "strong complementarity" – that is, to restrict our descriptions not merely to spacetime regions separated by horizons but to the reference frames of individual observers, wherever they are.'* Discussing the problem of infinity in relation to cosmic horizons she continues: *'Now strong complementarity is undermining the possibility of a single, shared universe. On a glance, you'd think it would create its own kind of multiverse, but it doesn't. Yes, there are multiple observers, and yes, any observer's universe is as good as any other's. But if you want to stay on the right side of the laws of physics, you can talk only about one at a time.'* She describes how this approach may have wider implications not only for cosmology, but for Quantum theory and the ongoing program in physics of Quantum Gravity.

Combining the observer-centric model of the universe with the strong complementarity approach of physics provides the basis of a framework by which to extend the centrality of the observer's experience through all dimensions, using a consistent *Flatland*-style dimensional structure.

Finity

All observer locations are equivalent. There exist an equal number of *Centre B's* to *Centre A's* with each pair comprising a single entity – one 'universe-experience' – with the total number limited only by the proximity of their centres to one another (*A* to *A*, *B* to *B*). The whole universe is filled with closely overlapping demispherical bubbles, centred on every (*x,y,z,t*) co-ordinate location in the whole of space through all time. Each observer therefore always stands at a unique viewpoint which is a 3-Dimensionally radial antipode of an origin of the Big Bang. An interesting question therefore arises: *Does the total number of Centre A/B systems increase over time?*

If the Planck quantities remain constant as space expands, then by analogy disks (as 2D slices completing a 3D sphere) should increase in number over time as each centre retains the same 'relationship of proximity' to those around. This presents us with the possibility of the following scenario:

- At ***Inception*** the universe would have begun with one single *Centre A/B* pair (cross-section), and
- At ***Completion*** the universe would end with the 'full number' of *Centre A/B* pairs (cross-sections)

Although the global universe may be considered mathematically to possess a 4-Dimensional 'shape', we would be ill-advised to try to imagine it from one viewpoint, because it comprises the sum total of all possible viewpoints through all time. In addition there is a sense in which the 4-ball universe is no larger than the cross-section I inhabit, because the way that 3-space encloses it is analogous to how the Earth's 2-space surface encloses its 3D volume.

The 3-space surface is finite, not in terms of physical shape as per the surface of a sphere, but instead the spherically finite nature of the universe is defined by the way in which light is unable to escape the system.

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[a] Amanda Gefter, *The* Universe, from *This Idea Must Die*, Edited by John Brockman, Harper Perennial 2015, P113

Conclusion

The observable universe is experienced from *Centre B* by each observer as a 3-sphere cross-section of the 4-ball[a], with corresponding origin at *Centre A*. The recession of *Centre B* from *Centre A* is governed by SR and applies equally to both massive and massless observers. Therefore, because each *Centre B* is always located at an antipode of *Centre A*, light cannot circumnavigate the universe, but must always have travelled a maximum of a half-circumference as viewed retrospectively by the observer.

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

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 8/15:

Expansion of the universe results from ongoing relativistic 'readjustment' of each observer's experience of *Centre A/B* recession at *c*

Abstract

Within the observer-centric model of the universe, exchange of information between the origin at *Centre A* and the antipodal observer at *Centre B* takes place in keeping with Special Relativity at the constant *c*. This exchange, termed *Centre A/B* recession, defines the frame of reference of each spacetime event. In terms of a consistent *Flatland*-based dimensional structure, the 3rd Dimension stacks up to form the 4th whilst, to the observer with mass, the ongoing increase in 3D information manifests as expansion.

Background: 'space itself'

When the website of Georgia State University points out the *'fact that the universe is expanding'*[b] the reference is to astronomers' measurements, derived by different techniques and checked using state-of-the-art technology by teams of talented individuals throughout the world, which show unequivocally that the universe is expanding. Light waves are continuously being stretched by the relentless expansion of an enigma we describe as *space itself*. Professor Frank Close of Oxford University: *'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.'* [c] Depending on the extent to which matter is 'gravitationally bound', matter itself does not exhibit this expansion. Observation indicates that galaxies remain at rest in relation to the immediate space around them but the space in between expands as per the 'dots on a balloon' or 'raisins in a cake' analogies. On a large enough scale the pattern of expansion should be homogeneous and is not thought, of itself, to dictate the global universe's shape, which is widely believed to be infinite.

Aside from what it may contain, there is a sense in which the space in between is not actually anything, with scientists using the term 'space' as a placeholder for something whose purpose is to define all the relationships between what comprises it[d]. This is reminiscent of a quote from physicist Carlo Rovelli where he describes the fundamental nature of reality as *'A world of happenings, not of things.'*[e] In addition the Standard Model describes a universe that is expanding at a rate which, over immense distances, is thought to exceed the speed of light.

As expressed within our *Flatland*-derived *'Edge-On' Principle*[f], the observer-centric model indicates that what we see in the observable universe is something playing out in the 3rd Dimension that is *actually going*

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[a] This essay was abridged from Chapter 34, *Book-Ends (Relativistic Expansion)*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] http://hyperphysics.phy-astr.gsu.edu/hbase/astro/hubble.html - Accessed 9th June 2015

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

[d] As per Descartes' *'no space without bodies and hence no empty space'* and Einstein's corroboration thereof: Albert Einstein, *Relativity*, *Appendix 5*, Routledge 2001, P140

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

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

on in the 4th. Consequently, if we reduce our concept of expansion to the level of an objectively physical event happening 'out there' and then compound the error by applying it to the global universe, we could be missing something of great import. Jayant Narlikar sounded this alarm in the final paragraph of *The Structure of the Universe* as early as 1977: *'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]

Information transfer

As the invariant of Special Relativity (SR), the constant *c* governs the recession of *Centre B* from *Centre A* (*Centre A/B recession*)[b]. Since the mathematical relationship between the origin at *Centre A* and the observer at *Centre B* is relativistic it does not change over deep time. The universe has therefore held this shape at all stages in its emergence from the Big Bang singularity up to the present. A direct link therefore exists between the *Centre A/B* half-circumference of light[c] and the phenomenon of the universe's expansion. From this it is clear that it is not light *per se* that is important, but the transfer of information between *Centre A* and *Centre B* at the constant *c*. This applies equally to the massless particle, the conscious observer, or the point-mass located at any spacetime event. Expansion therefore occurs as the expression of the massive observer's changing relationship at *Centre B* with antipodal origin at *Centre A*, so that the phenomenon of the universe's expansion is observer-centric, as shown in *Fig.1:*

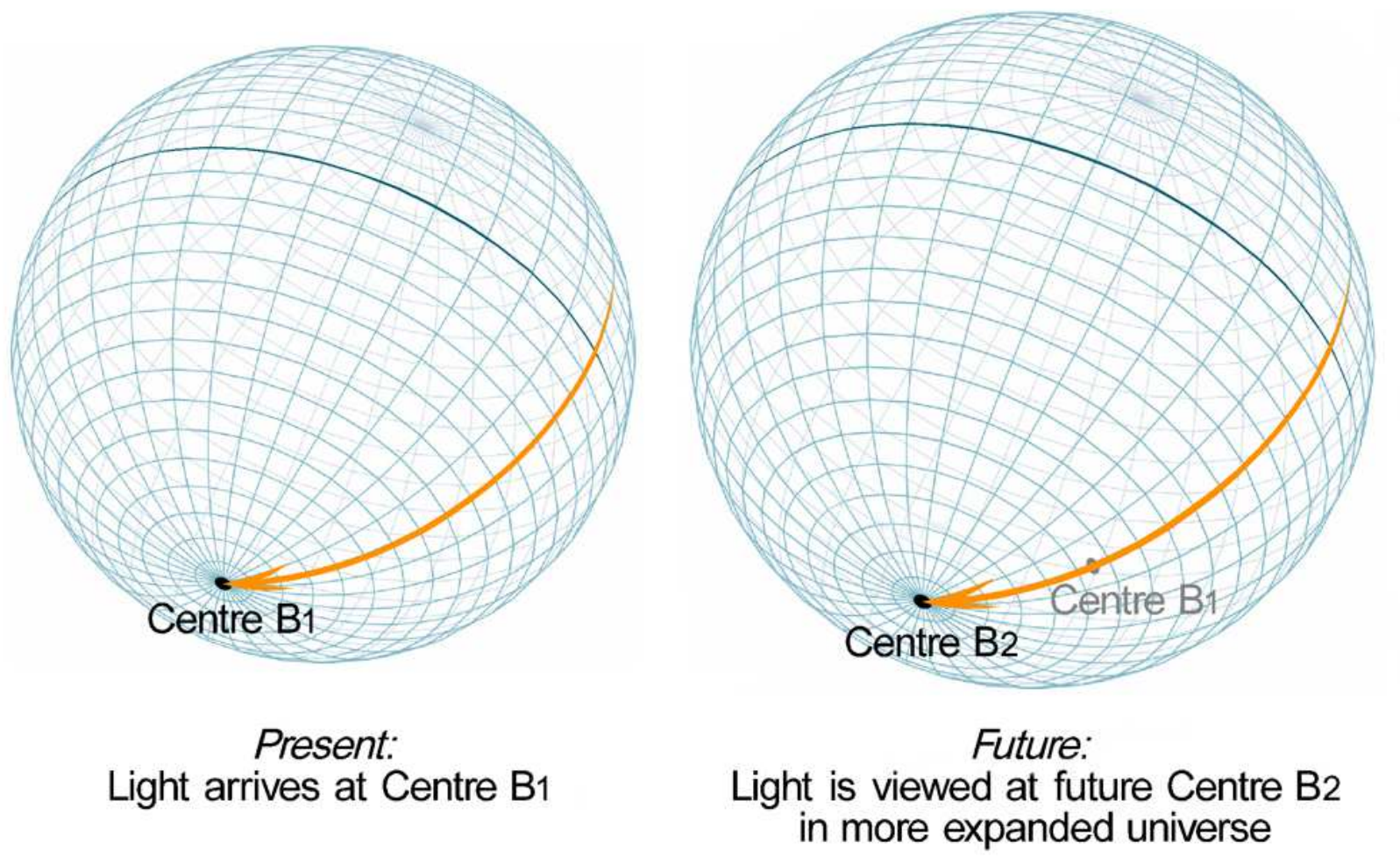

Fig.1 Shifting the analogue down by one dimension, the photon is always viewed by the observer as travelling at the same speed as the information transfer of *Centre A/B* recession. It is therefore always located at a *Centre B* which corresponds to an antipode of *Centre A*. This demonstrates how expansion of the universe takes place as the ongoing relativistic 'readjustment' of each massive observer's experience (Observer 1 at *Centre B1*, then Observer 2 at *Centre B2*) of *Centre A/B* recession in a universe which continuously requires more information to define.

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[a] Jayant Narlikar, *The Structure of the Universe*, Oxford University Press 1977, P249-50
[b] See Essay 7
[c] See Essay 7

From this we see that the phenomenon of expansion comprises the relativistic outworking of the ever-increasing distance that light is viewed by the observer as having travelled throughout the cosmos between origin and observer (i.e. between all *Centre A's* and corresponding *Centre B's*). This necessarily increases the radius of the view, because the massive observer is the constant spectator of a universe in which light is *observed* to have travelled farther, and, since the origin at *Centre A* must always lie on the observable universe's surface[a] with the observer at its centre[b], *Centre B*, all observed distances within the observable sphere increase relativistically to compensate, as shown in *Fig.2:*

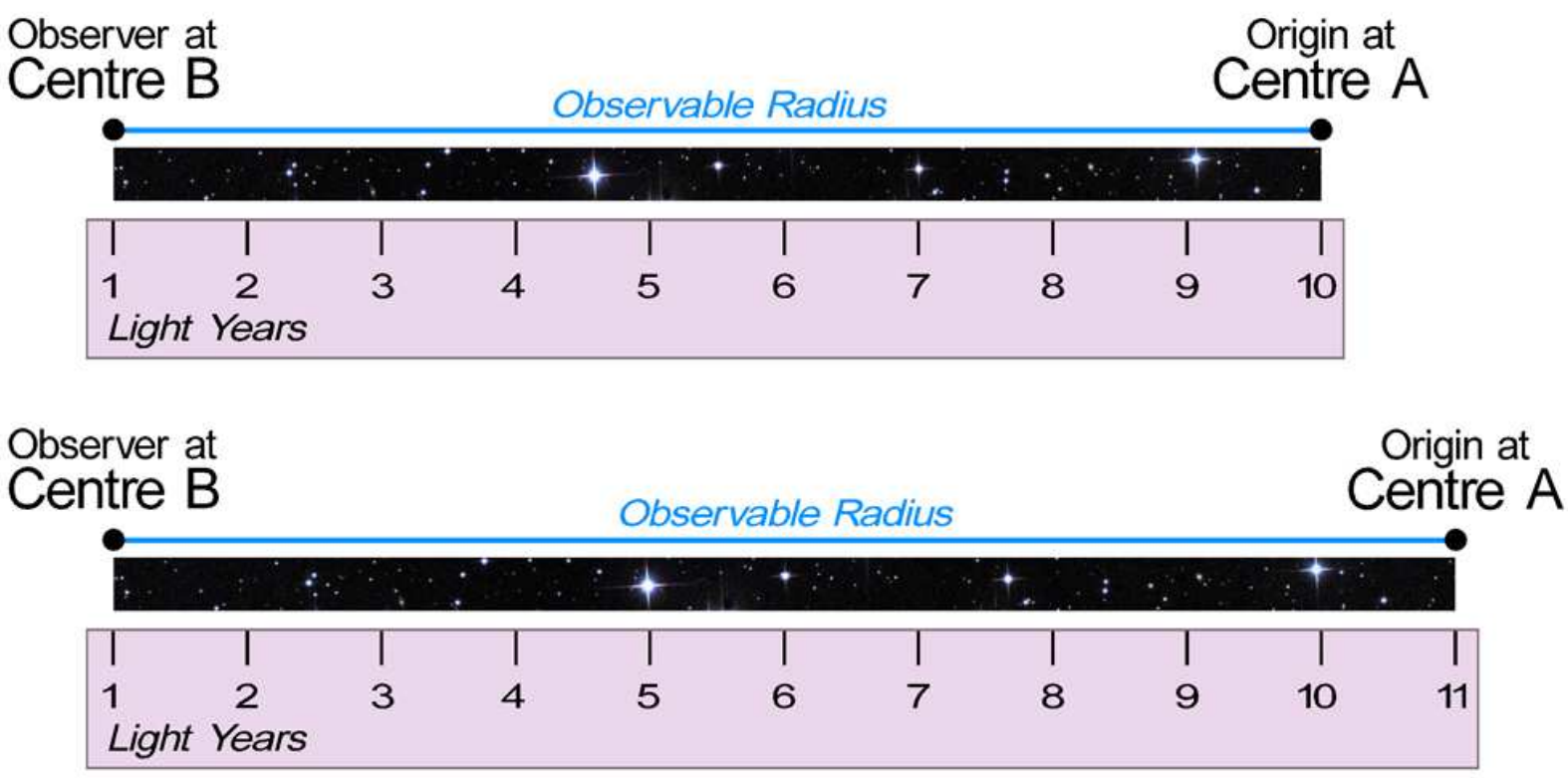

Fig.2 For the purpose of illustration we will imagine the universe to be 11 years old. A year ago it was 10 years old but light has been travelling between *Centre A* and *Centre B* for another year. As a result, relic radiation is 1 year older and the observer looks out on a universe whose observable radius has expanded (in look-back distance) by one light year. Because the universe is observer-centric this experience is repeated at every location in space as a *Centre B*, and all objects (observers) are now spread evenly through a radius of 11, rather than 10, light years.

Because *Centre A/B* recession obeys SR, nothing may exceed the constant *c* as it governs the unfolding of the universe. (As described in Essays 3, 4, and 5, the universe's Pac-Man topography means that the 'horizon problem' of superluminal recession produced by the faster-than-light expansion of 'space itself' does not apply.) Expansion throughout space is the product of the ever-increasing amount of information required to define it[c], as experienced relativistically[d] by all observers with mass[e]. The invariant nature of this expansion also rules out the possibility of Cosmic Inflation.

The apparent superluminal recession of distant galaxies is accounted for by 2D equatorial lensing, described partially in Essay 4 but more fully in Essay 13.

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[a] Due to the 'Antarctica' effect. See Essays 4 and 5

[b] See Essay 5

[c] A snapshot of the present universe is always the result of a greater number of events than any snapshot from the past.

[d] *Centre A/B* recession is governed by SR for all observers. Its direct consequence, *Centre B/B* propagation, will be examined in Essay 14.

[e] The massless observer will not experience expansion because the information required to define expansion includes time and distance.

Is expansion 3D or 4D?

The mathematical success of our *Flatland* analogy is helped by the assumption that *Sphere* passes through Flatland at a constant speed. Although not specifically demanded by EA Abbott's storyline this is critical to its use as analogy, corresponding to our observed constant of nature *c*, the speed of light and gravity. Physicists need not give a reason why *c* is constant, therefore a reason need not be given why *Sphere's* analogous descent (or ascent) is interpreted as constant.

The geometry of *Flatland* shows that it is not necessary for the 4-ball *itself* to expand for us to experience a 3-Dimensionally expanding universe. This is very easily demonstrated by the analogue of *Sphere* passing through Flatland, using the following original illustration by EA Abbott:

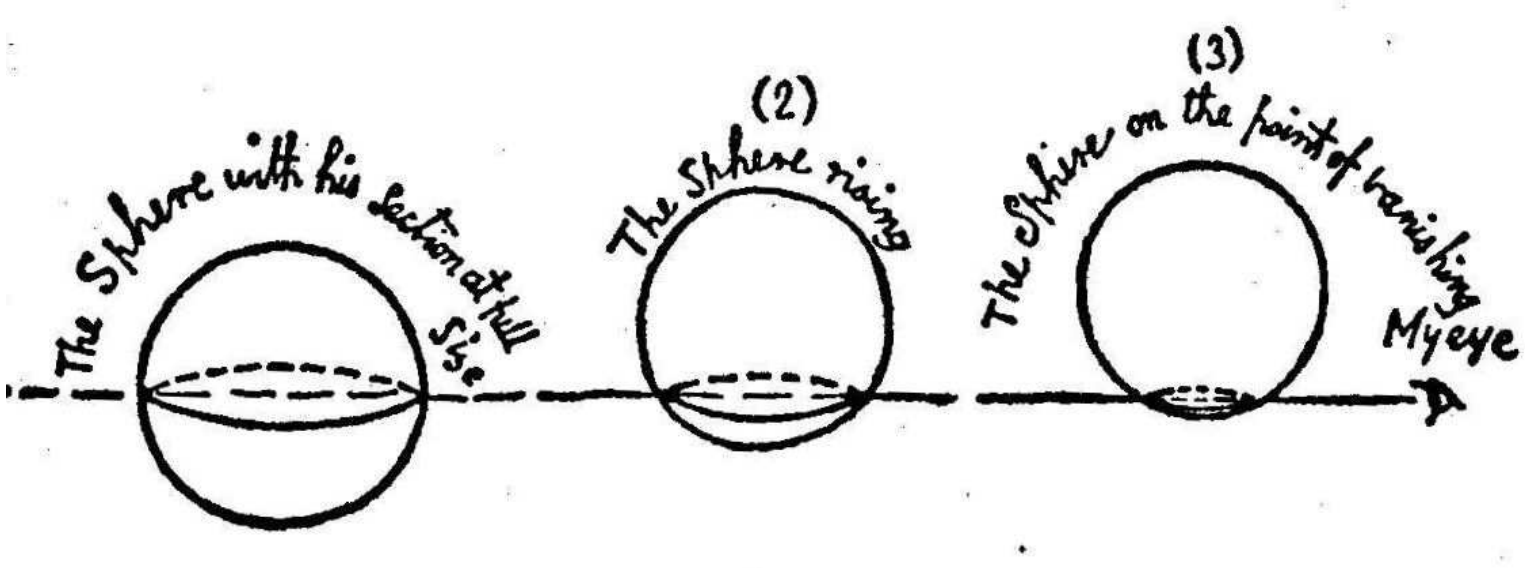

Fig.3 EA Abbott's original drawing of *Sphere* cross-sectioning through Flatland. Note how *Sphere* himself remains unaltered, whilst he is viewed in cross-section from a dimension below – by *A Square's* eye, to right – as an entity which expands from a point to his 'equator', then contracts again to a point.

Simply by allowing the rate at which 3D *Sphere* passes through 2D Flatland to be constant we derive a remarkable analogue of a 4-Dimensional universe passing through the 3rd Dimension. (Note: the *Flatland* analogy is the converse of our natural inclination to think of the 3D present as passing through a 4th Dimension.) We view the universe *from within* in the process of stacking, just as *A Square* viewed the 'Circles' of *Sphere*. As per Abbott's drawing, *Sphere's* 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 3-ball remains unaltered. *Sphere* himself is not required to expand, and, by extrapolation, neither would our 4-ball universe. The 4th Dimension subsists as an unchanging entity – a block universe – perceived by those who experience it one dimension lower as a 'shape-shifting' sequence of 3D spherical cross-sections.

By contrast, in the book *The Fourth Dimension* (released to commemorate the centenary of *Flatland*), mathematician Rudy Rucker writes that *'A widely held present-day view of the universe is that our space is an expanding hypersphere [4-ball], which started out as point-sized…'*[a] Considered in terms of dimensional principles, Abbott's illustration and Rudy's observation (which I hasten to add Rudy does not necessarily endorse!) represent two contradictory scenarios because, technically, as a series of 4D cross-sections an *'expanding hypersphere'* should stack[b] into a 5th Dimension. This rather sloppy cosmological oversight demonstrates the extent to which simple yet consistent *Flatland*-based geometrical principles have traditionally been underestimated or overlooked.

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[a] Rudy Rucker, *The Fourth Dimension*, Houghton Mifflin Company 1884, P162

[b] Although stacking into a 5th Dimension is mathematically feasible, there is nothing in the present discussion which demands it.

Conclusion

Flatland presents us with a consistent dimensional structure within which expansion of the observable universe may be explained in keeping with observation. Within the observer-centric model, 3D space is viewed by the massive observer as expanding because there is a continuous increase in the amount of information required to define the increasing separation at *c*, in keeping with SR, between each observer at *Centre B* and corresponding antipodal origin at *Centre A*. It is this transfer of information which defines all *Centre A/B* relationships throughout the universe[a].

The equal significance at each spacetime event of this relativistic expansion would imply that the past and future universe exist as a single and complete entity in the 4th Dimension – a block universe. Whilst total information defining the 4-ball is not required to change, the increase in information required to describe the process of stacking the 3rd Dimension into the 4th (or passing the 4th Dimension through the 3rd) is viewed as a dynamically unfolding process *from the observer's dimensional viewpoint*.

The observation that 'space itself' expands whilst matter does not is explained by the relativistic nature of the interaction. As an example: the stationary observer will experience her own *Centre A/B* recession at *c* as her passage through one year of time, and although her atomic structure will not physically have expanded, the radius of her universe will have expanded by one light year.

Note that this expansion is not the result of an empirically unverified 'energy of the vacuum' acting in opposition to gravity by an unknown mechanism. The idea that matter resists expansion due to being gravitationally bound is an assumption based on the Standard Model's assertion that gravity is pulling the universe to collapse whilst dark energy is pushing it to expand. The observer-centric model shows this scenario to be a red herring and a hindrance to progress in physics, as discussed separately in Essay 12.

[a] And also all Centre B/B relationships. See Essay 14

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 9/15:

Describing the relationship of the observer to the path of light through the observer-centric model of the universe

Abstract

In the observer-centric model the universe is experienced by the observer as though that observer occupied the centre of the universe, regardless of the total number[b] of observer locations. By the process of 'rolling the balls'[c] a series of diagrams describes the true positions of celestial objects, as viewed by a single observer.

Travelling light

In every direction, the line that stretches from the observer at *Centre B* to the origin at *Centre A* cuts a cross-section through the history of the universe which is recorded in travelling light. This divides the nature of the observed light's path in two:

1. Light from nearer objects (which are located within the observer's own southern demisphere) follows a straight path to the observer, affected only by local spacetime curvature.
2. Light from more distant objects (which are located within the observer's opposite northern demisphere) follows a straight path to the observer through the northern demisphere, crossing the 2D equator before following the same path as nearer light.

The first of these is straightforward whilst the second – the path of distant light through the northern demisphere – is more complex and we will be considering it here.

Rolling the balls

Unlike the cosmic microwave-background radiation (CMB), distant galaxies are not projected 'Antarctica-style' all around the sky[d]. This is due to the fact that the CMB was released as an everywhere-event close to the beginning of time[e], whereas objects such as galaxies, supernovae, quasars etc are localised. In order to define the light's path through both demispheres and find the position at which the object will be viewed we must perform the action described (in Essay 5) as 'rolling the balls'[f].

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[a] This essay was abridged from Chapter 31, *Light from Distant Galaxies*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Because the stacking process appears to comprise the deployment of discrete slices from a 'start' to a 'finish' their number should, in theory at least, be finite. On completion they 'fuse together' in keeping with the *Principle of Character*.

[c] See Essay 5

[d] See Essay 4

[e] Currently measured at 380,000 years after the Big Bang.

[f] Or any geometrical equivalent.

As the 3-sphere surface of a 4-ball, the twin demispheres (3-hemispheres) of the observable universe share a 2D equatorial surface[a]. The observer views the universe from *Centre B* as a 3-Dimensional cross-section[b], with *Centre A* viewed omni-directionally[c] on the extreme surface of the observable sphere at maximum distance (which equals the combined radii of both demispheres as defined by *Centre A/B* recession). This affects the observed positions of celestial objects in the northern demisphere in ways that are, although consistent with the Pac-Man universe, not intuitively apparent, constituting non-Euclidean 'bending' into a 4th Dimension.

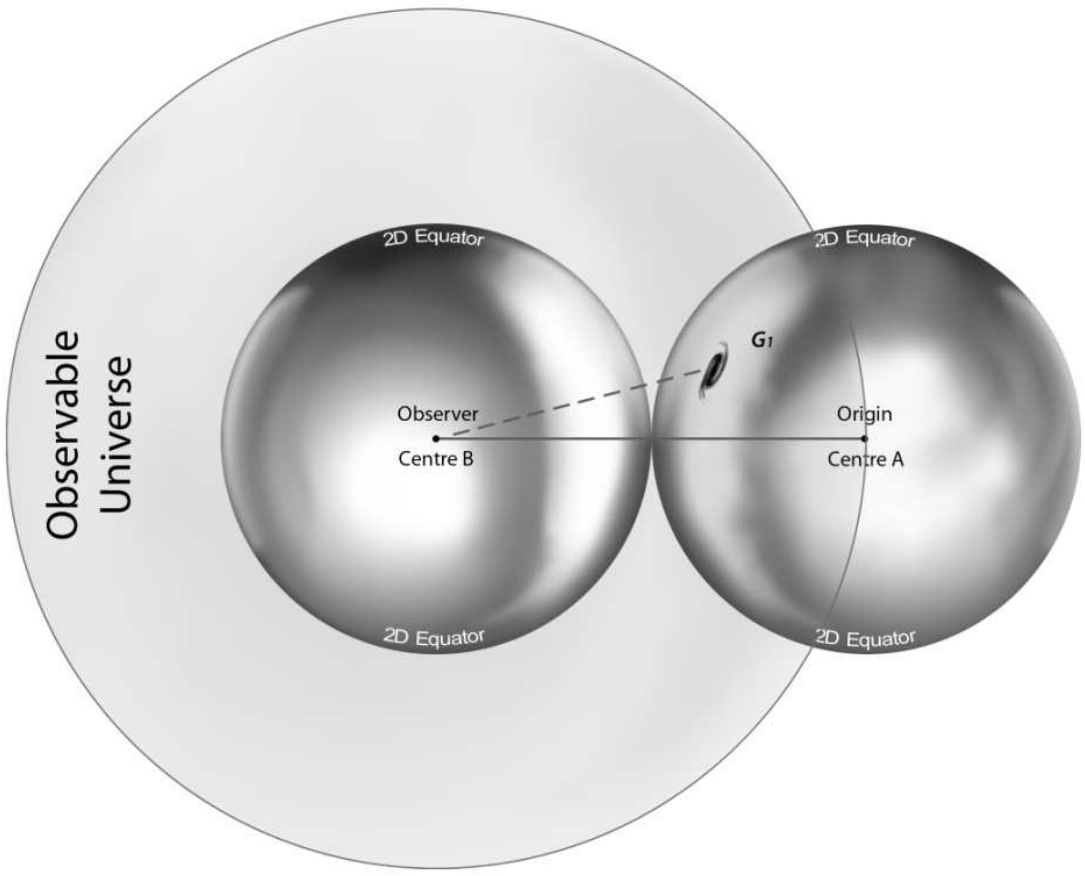

Fig.1 This is the position of galaxy *G1* relative to the origin at *Centre A*. (In look-back distance this may be about 9 BLY.) As the observer looks out from *Centre B* toward *Centre A*, *G1* looks at first glance to be off to the left of the observer's field of vision (dotted line). However this does not represent the galaxy's true position in the sky (i.e. where it is viewed by the observer).

---

[a] See Essay 5

[b] Spherical cross-section of the hypersphere (4-ball). The lines that radiate to join *Centre A* to *Centre B* correspond to the lines of longitude on the Earth, joining the poles. Imagining each demisphere filled with onion skin layers, these spherical surfaces are the 2D analogue of the 1D lines of latitude around the Earth, which similarly increase to maximum at the equator, then contract.

[c] By the 'Antarctica effect'. See Essay 4

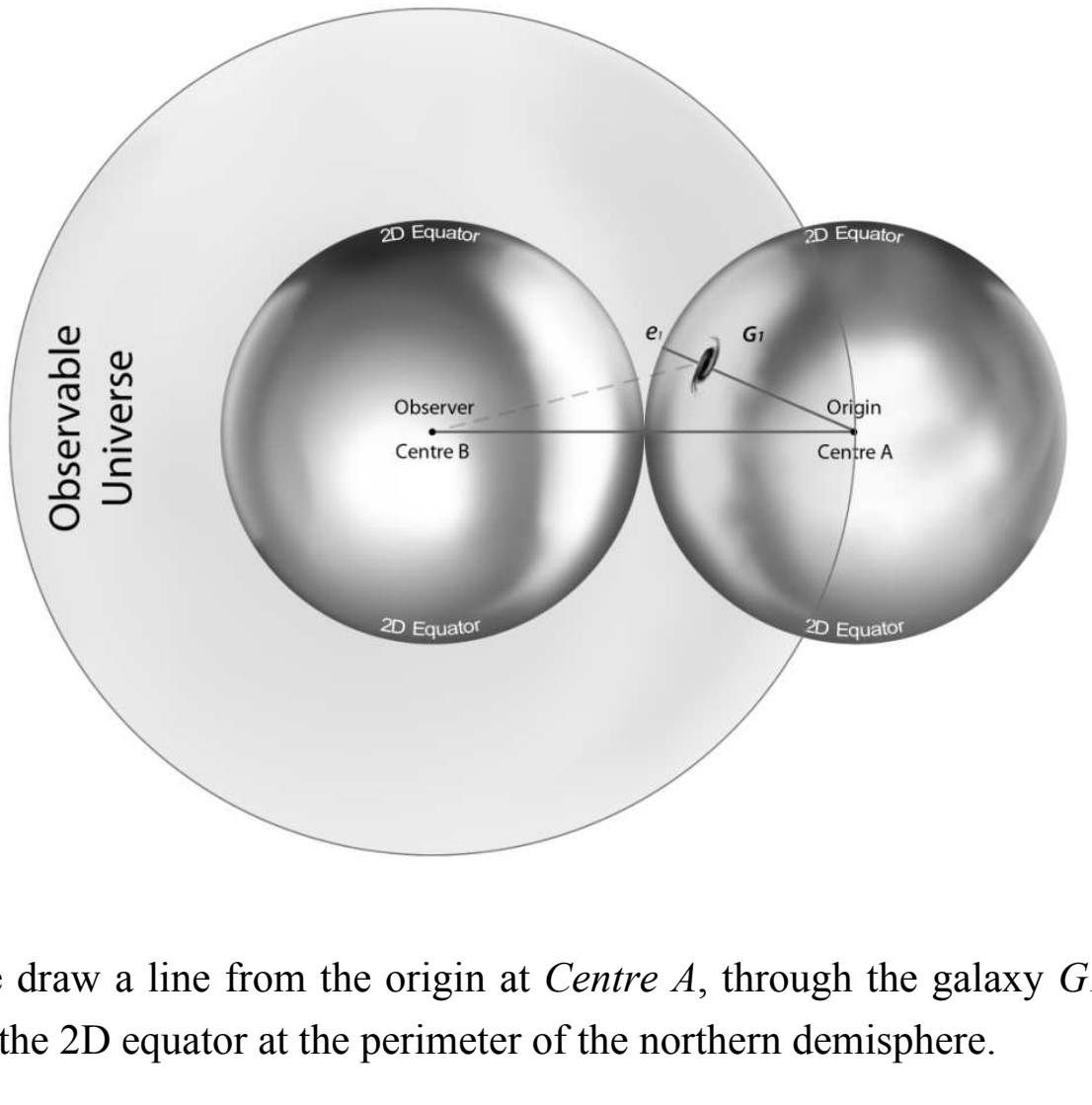

Fig.2 To find this we draw a line from the origin at *Centre A*, through the galaxy *G1* and continuing as a radius to a point *e1* on the 2D equator at the perimeter of the northern demisphere.

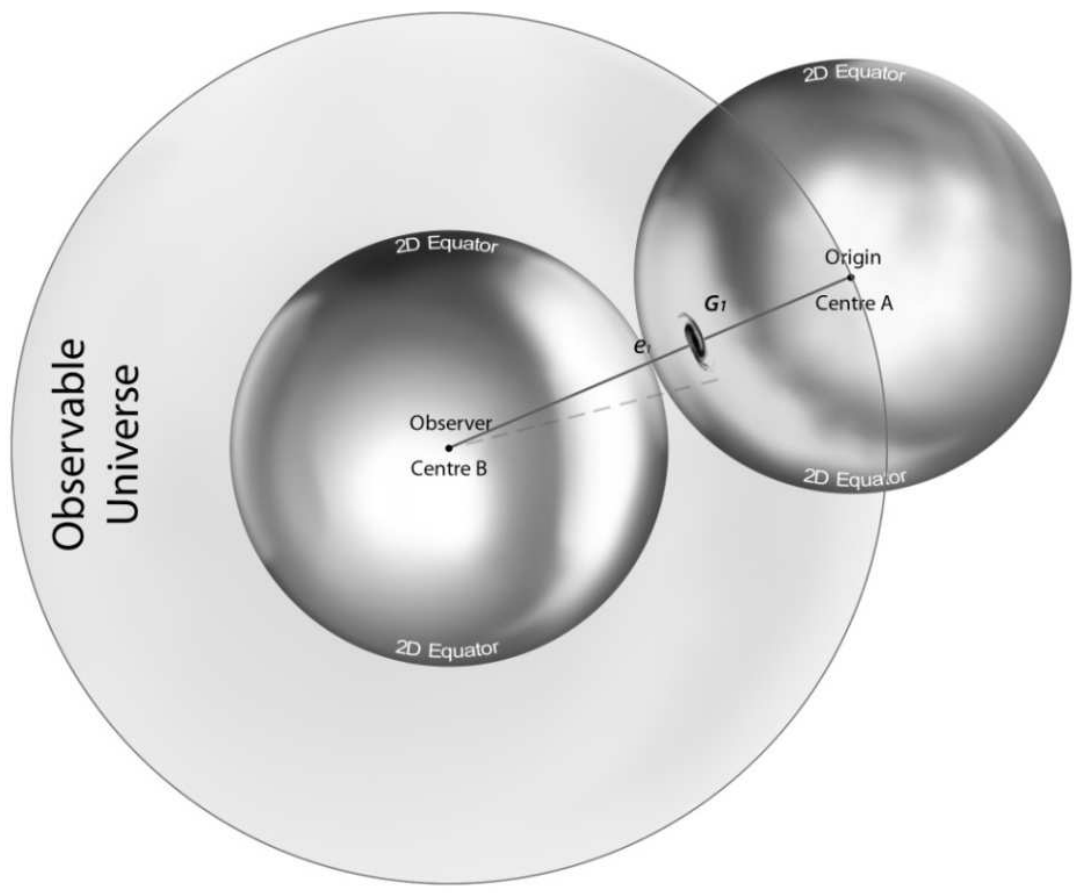

Fig.3 We then 'roll the balls' until equatorial point *e1* meets its corresponding equatorial point on the perimeter of the southern demisphere (as these are the same point), and continue the line as a radius to the observer at *Centre B*. This is now the correct position in which the galaxy is viewed. Note that the line through the object must always be a straight line joining *Centres A* and *B*.

But what happens to the light that radiates from galaxy G1 in other directions?

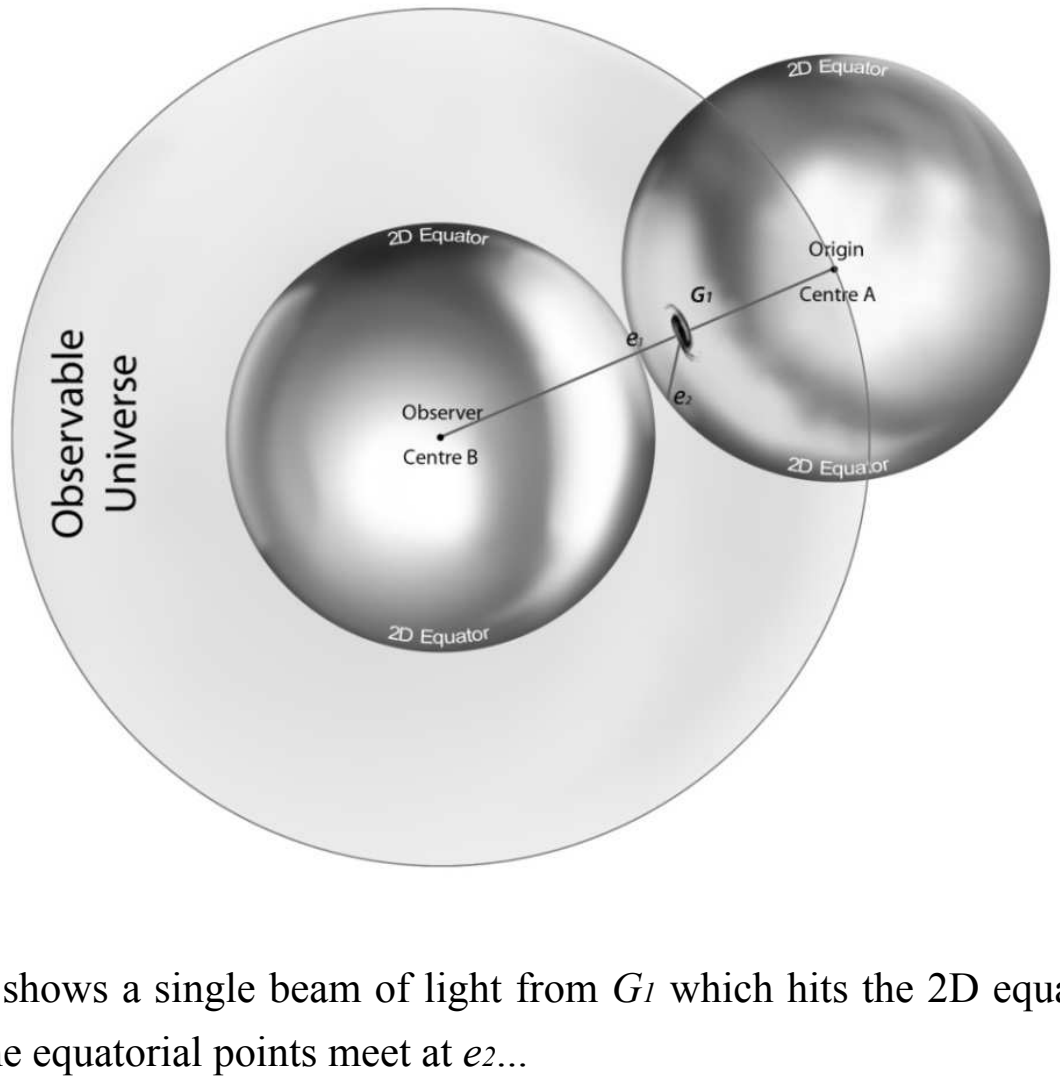

Fig.4 This illustration shows a single beam of light from G_1 which hits the 2D equator at point e_2. Again we roll the balls until the equatorial points meet at e_2...

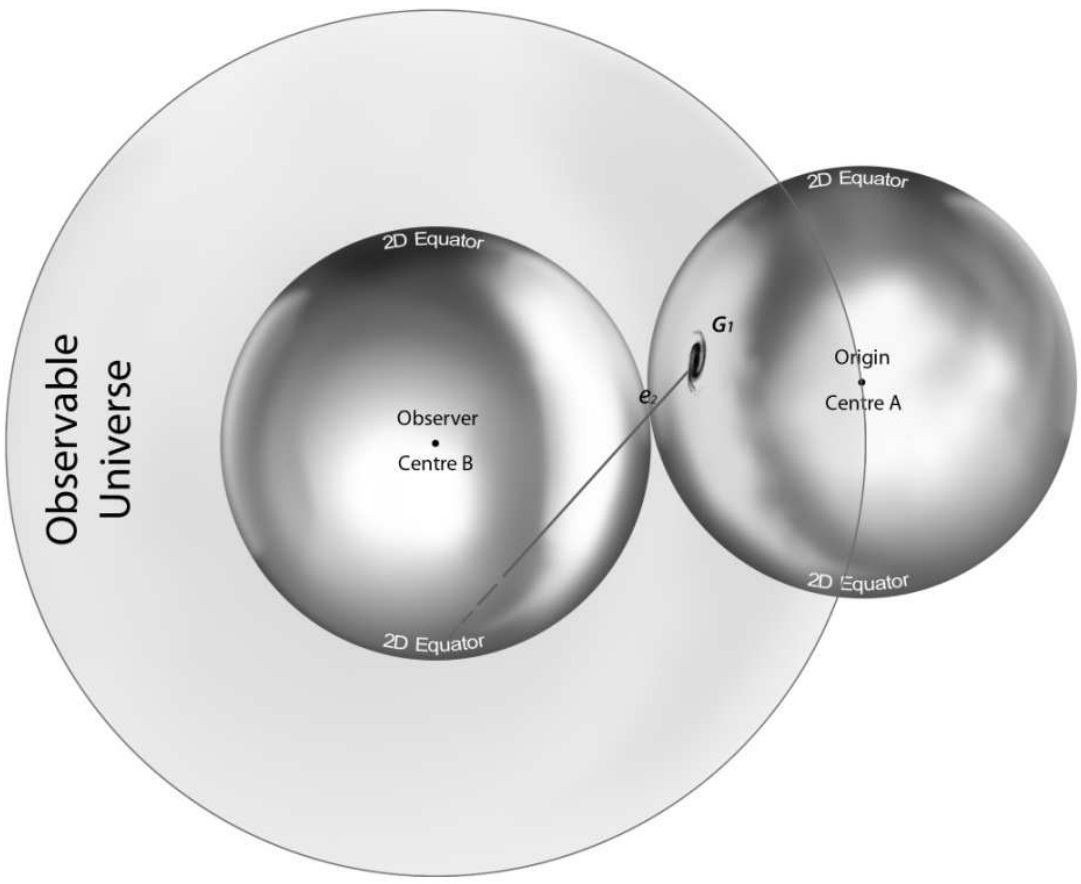

Fig.5 The light crosses the equator in a straight line at an angle relative to the observer. We may do the same for every beam of light which radiates away from the galaxy in every direction, rolling the balls so that each beam crosses the equator at the same angle it arrives. In this way, the observer only sees light from one direction, which is always in line with the origin at *Centre A*.

These angles are only relevant to this observer's position at *Centre B*. 'Other' light from the object will not be viewed by this observer but is available throughout the universe to be viewed from other *Centre B's*. Each observer at their own *Centre B* on the light's path will view the light as having crossed the equator in line with their own corresponding *Centre A*, similar to *Fig.3* but viewing the galaxy at a different aspect.

The far side

Now let's look at what happens to light from a galaxy located beyond *Centre A* at the far side of the northern demisphere:

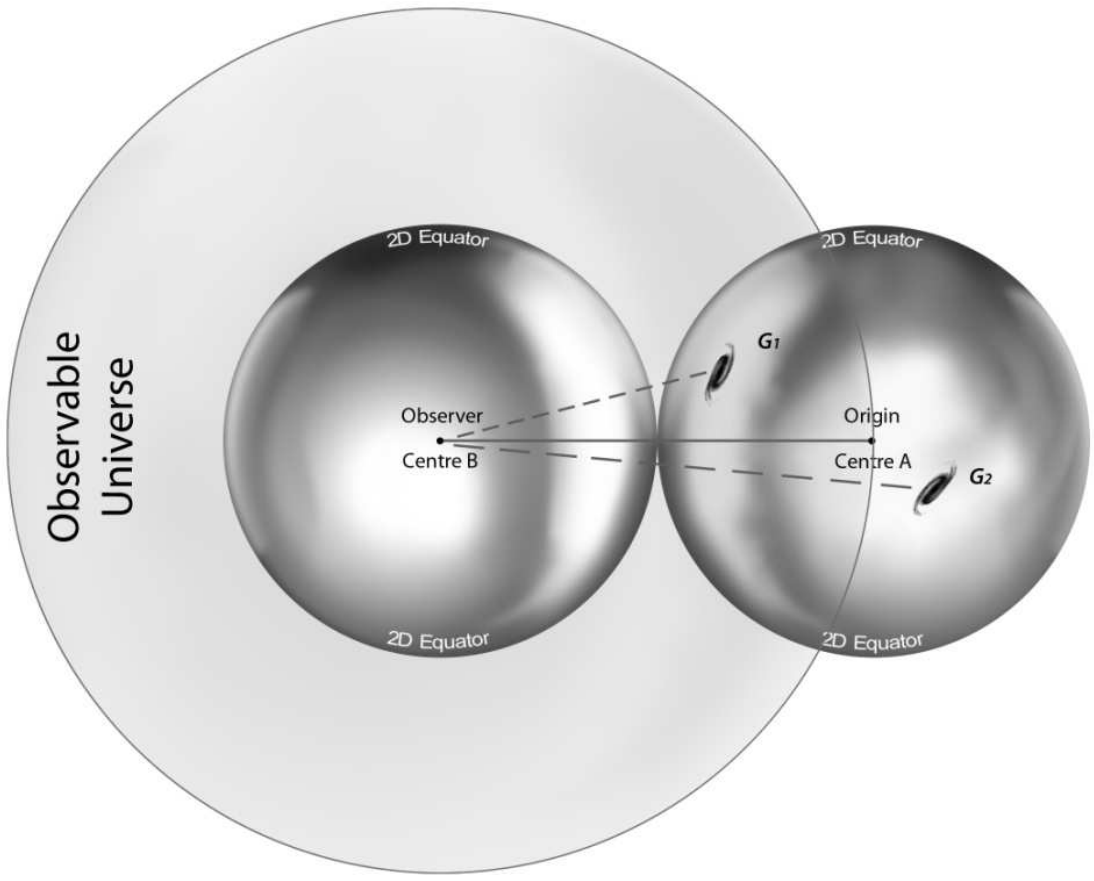

Fig.6 At first glance galaxy *G2* appears to lie beyond the observer's *Centre A* origin, and therefore beyond the observer's cosmic horizon.

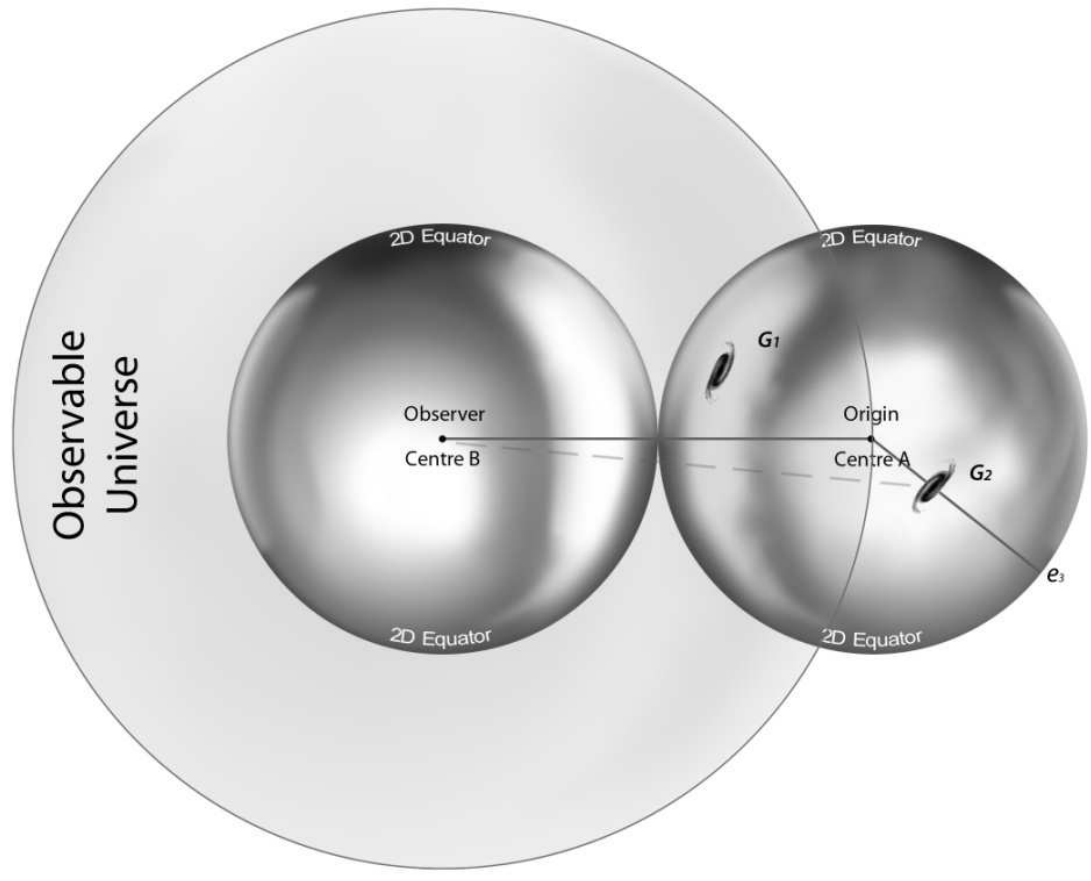

Fig.7 However, we must now perform the same operation as above, drawing a radius from the origin at *Centre A* through the galaxy *G2* to the perimeter of the northern demisphere at the equatorial point *e3*.

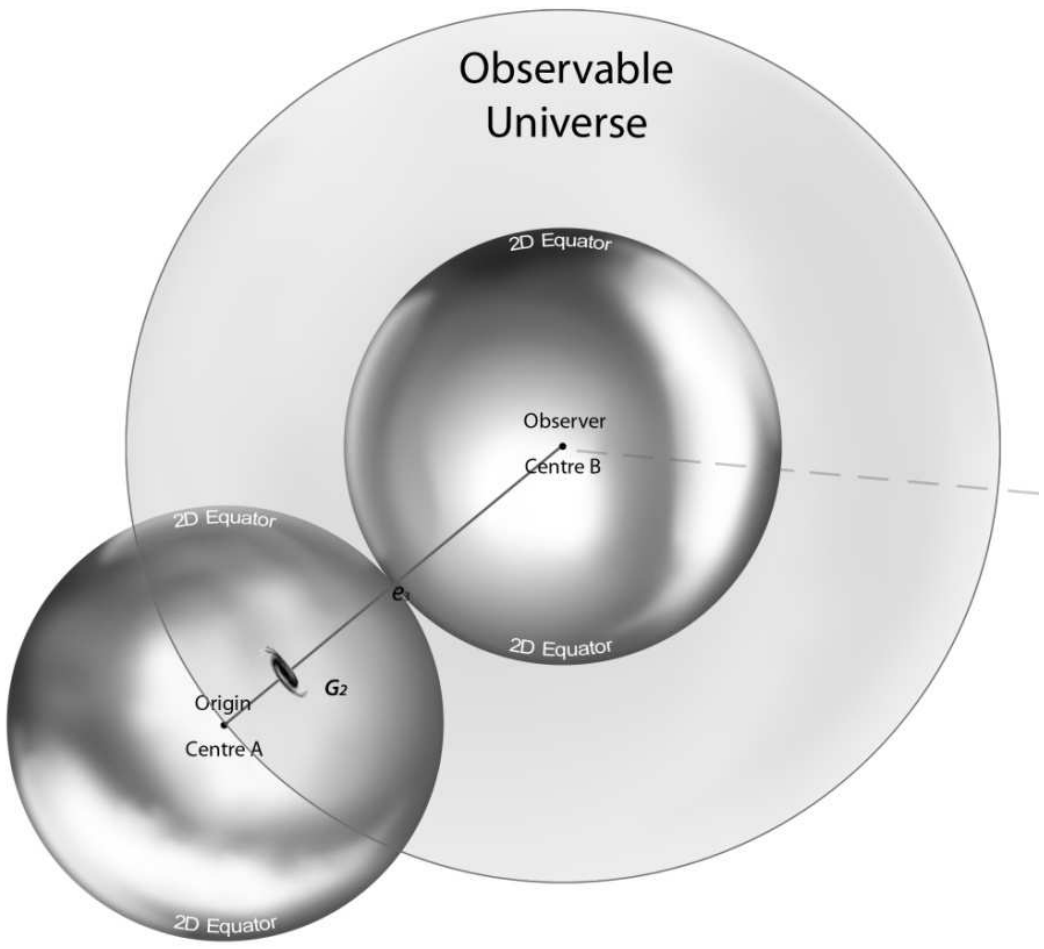

Fig.8 We now roll the northern demisphere right round until the point *e3* meets the equatorial surface of the observer's southern demisphere. The line continues as a radius to the observer at *Centre B*. This is now the correct position in which the observer views the galaxy ('behind' the observer), and the distance may now be seen to be less than the distance from the observer to the edge of the observable universe. In this way, everything that the observer views from *Centre B* is nearer than, but in line with, *Centre A*.

Pac-Man

This rolling process is only required to describe the positions of objects which lie beyond the 2D equator. From the observer's viewpoint the position of an object in either demisphere is viewed in exactly the same way: radially in 3D at a point on the line between origin at *Centre A* and observer at *Centre B*. As this applies to all light in the universe including the CMB we may state it as a principle:

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.

This principle describes how each observer throughout the global universe (i.e. the sum total of all *Centre B's* in space through time) views all the same phenomena but at a unique aspect, accounting for the isotropy and, by implication, homogeneity of the universe at larger scales. Consequently there are no distant galaxies located farther from the observer than the distance that light has had time to travel. In this way, the *Pac-Man Principle* solves a major horizon problem of cosmology[a].

[a] See Essay 4

Dark Flow

Discovered by Sasha Kashlinsky in 2008, the Dark Flow refers to a cluster of 1,400 galaxies racing headlong toward a blank patch of sky between the constellations of Centaurus and Vela, likely the result of gravitational attraction by an unidentified supergiant structure. This presents us with the possibility of a testable hypothesis for the finite 3-sphere universe which, although in itself not the product of a difficult inference, as far I can tell has not yet been performed.

Of these hastening galaxies science writer Michael Brooks writes, *'Many people have argued that the clusters must be experiencing a gravitational pull from some enormous structure just beyond the edge of the visible universe.'*[a] Although he points out that supergiant structures have since been found such as the Huge-Large Quasar Group which spans 5% of the observable universe's diameter, no structures with the required gravitational pull exist in the right area. Brooks writes, *'Its as though they are racing to escape the universe.'*

However, if the universe is configured according to the observer-centric model the source of attraction should instead be found within the observable bubble, by 'rolling the balls' to locate the antipodal point from their direction of escape as per the *Pac-Man Principle*[b]. Now let's examine this in more detail; at time of writing the five largest identified galaxy superclusters are:

Order	*Name*	*Location*	*Distance*
1	Hercules-Corona Borealis Great Wall	Draco/Hercules	10 BLY
2	Giant GRB Ring	Andromeda/Triangulum	7 BLY
3	Huge-LQG	Leo	9 BLY
4	U1.11	Leo/Virgo	8.8 BLY
5	Clowes-Campusano LQG	Leo	9.5 BLY

The galaxies of the Dark Flow are racing to exit the universe between the constellations of Centaurus and Vela; if we mark this position on a globe of the night sky, then pass an imaginary diametric line through the centre of this globe (or roll the balls through 180°) to find the antipode, this emerges in the constellation of Lacerna, the lizard, *directly between the approximate centres of the two most massive structures and within the expanse of sky covered by both*. This is an amazing result, suggesting that the gravitational influence of these two filamentous structures may be pulling on the Dark Flow.

However, something potentially even more significant may perhaps be found by looking at the location in the sky of the Huge-LQG, U1.11, and the Clowes-Campusano LQG – respectively the 3rd, 4th, and 5th largest structures – which are all lined up over distance in the direction of the constellation Leo. If the conclusion of the previous paragraph is correct it is likely that these three structures should be pulling a second 'dark flow' toward themselves, racing to escape the universe through Leo's antipodal area in the constellation of Aquarius.

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[a] Michael Brooks, *At the Edge of Uncertainty*, Profile Books 2015, Ch9

[b] *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.

As a prediction emerging from the observable universe as a finite 3-sphere this is testable by observation. If found to exist this Aquarian dark flow would constitute serious evidence for the observer-centric model.

Conclusion

No physical thing can exist outside the twin demispheres (the 3-sphere). They share the same surface, therefore to leave the one is to enter the other. This constitutes a compact system as experienced by any observer at any location, and every physical thing in existence must lie between the observer and the origin[a]. As a result, *the distance from the origin at Centre A to the observer at Centre B marks the longest distance between any two points in the universe*. This is the radius of every observer's observable universe and therefore the radius of the global (4-ball) universe, as measured in 'onion-skin' cross-section at any point in space and time. The universe as observed by any observer from any spherical cross-sectional centre is therefore the whole universe and is, as postulated by Einstein in 1916, *'finite in the manner of the spherical universe'*.[b] From this we may see that – contrary to the current Standard Model – 'space itself' does not expand superluminally, because information may only ever travel between *Centre A* and *Centre B* which it is observed to do at the constant *c*. 'Opposite sides of the sky' from the observer are not superluminally distant from one another. They are the same point, viewed from opposite sides.

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[a] Of course, as a bare philosophical statement, *'every physical thing in existence must lie between the observer and the origin'* is clearly true, but the observer-centric model supplies a geometrical description.

[b] Albert Einstein, *Relativity, Section 31*, Routledge 2001, P114

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 10/15:

Describing the relationship of two observers to the path of light through the observer-centric model of the universe

Abstract

In the observer-centric paradigm all that exists is viewable by all, from different angles and at different aspects. By the process of 'rolling the balls'[b] a series of diagrams describes the true positions of celestial objects as viewed by two observers.

Observer 2

A 2nd observer, Λlienna, lives on a planet 4 billion light years away. I can see her star system and she can see mine. But how does Λlienna view galaxy G_1? To understand this we must draw a new diagram with Λlienna as Observer 2. (For simplicity we will place Λlienna on the same path of light illustrated in *Figs.4* and *5* of Essay 9):

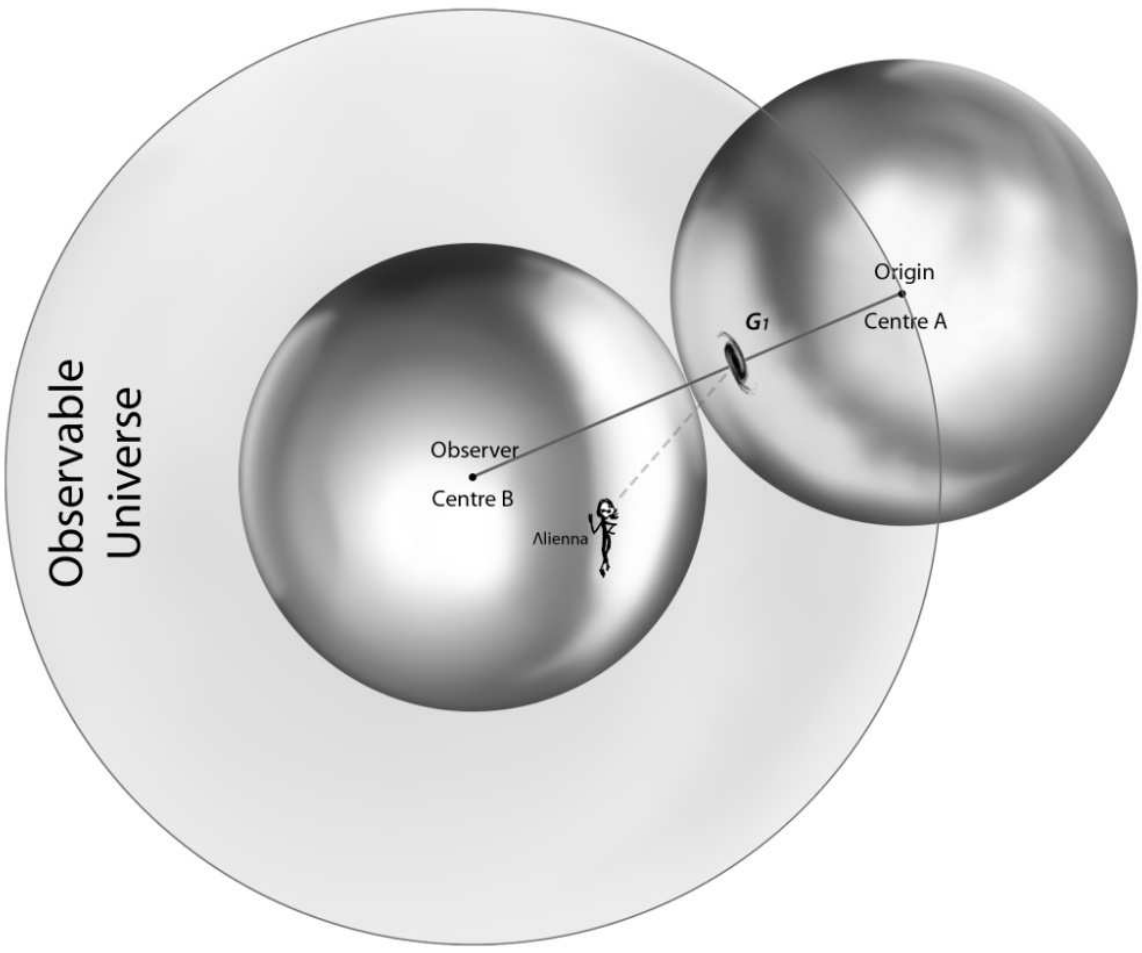

Fig.1 This illustrates the path of light from G_1 to me as I experience it from my own *Centre B*, and also the path of light from G_1 to Λlienna as I might imagine it at first glance. However, because the universe is observer-centric I do not view the universe 'objectively' as it is. To Λlienna, galaxy G_1 is not inside my opposite demisphere because observer-centricity places her at the centre of her own observable universe experience.

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[a] This essay was abridged from Chapter 31, *Light from Distant Galaxies*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] See Essay 5

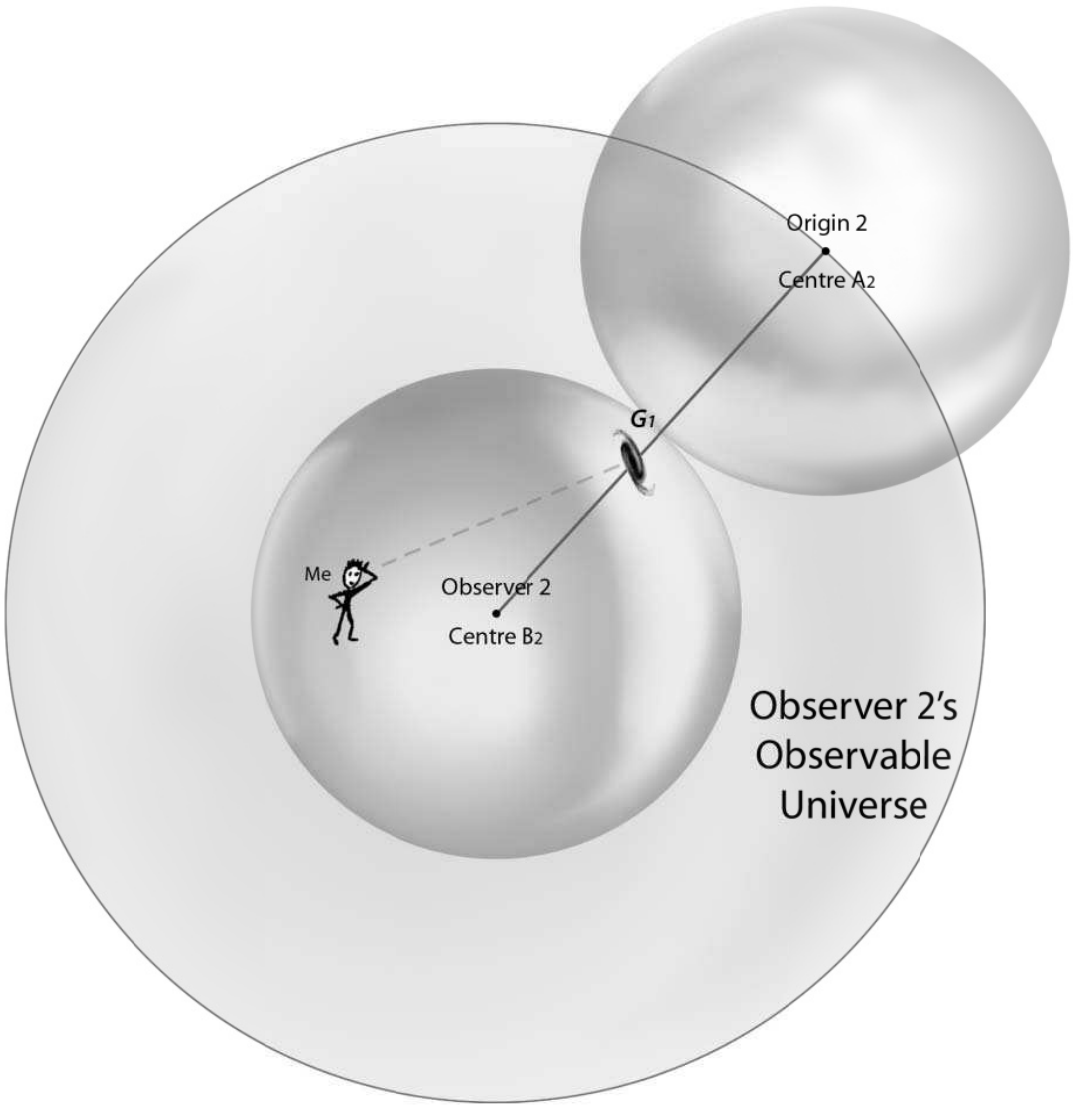

Fig.2 We now place Λlienna as Observer 2 at the centre of her own twin demisphere experience which we will designate *Centre B2*. This shows Λlienna's view of the universe. Galaxy *G1* is viewed by her as located within her own (southern) demisphere because the distance between them is less than the radius of a demisphere. The other thing to notice here is that, whereas I viewed the galaxy *G1* straight on, it is viewed by her at an angle. Observer 2 necessarily views everything in the universe at a different aspect from Observer 1, unless she is on the direct line of sight between Observer 1 and an object.

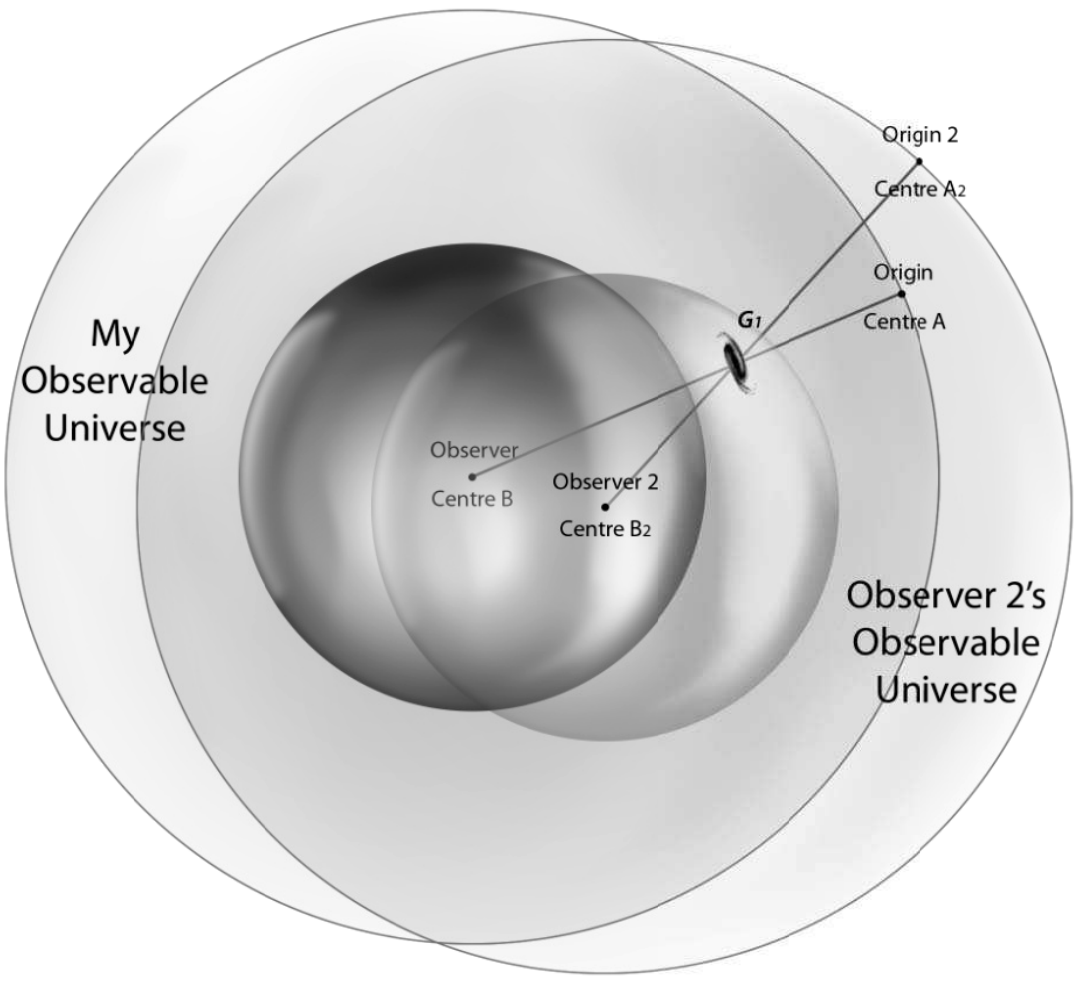

Fig.3 Now let's superimpose Λlienna's observable universe on mine. It shows the observer-centric experience of two observers approximately 4 BLY apart. Just as I do, she experiences the 4D global universe

in 3D cross-section and it looks the same as mine, but with one major difference: she views everything at a different aspect, with some things from 'behind'. In order to define the relationship between these two observer-based 'observable universe experiences' in terms of the location of an object as viewed from either, the first thing we must take into account is the fact that:

- *Centre A* is only of relevance to Observer 1, whilst
- *Centre A2* is only of relevance to Observer 2

As a result, galaxy *G1*, which was located in my opposite (northern) demisphere, is located in Λlienna's own (southern) demisphere. Although Λlienna *appears* to view light originating from beyond my observable universe (and vice versa), when the two 'observable universes' are superimposed as per *Fig.3* her location is seen to lie within my observable universe, therefore all that she sees must also lie inside my universe, because the twin demispheres are 3-Dimensionally closed regardless of the observer's location, and the same process described above – drawing a radial line from *Centre A* through a viewed object's location, then rolling the demispheres until they touch – may be applied to any object at any distance, as viewed by any observer at any location in space and time.

Please note that it is not possible to represent all line trajectories accurately in a single diagram[a]. This geometry means that although light passes in straight lines through each demisphere and across the 2D equator (being straight in all 3-Dimensions of length, width, and depth), non-Euclidean 'bending' into the 4th Dimension takes place with respect to each observer at the equatorial surface, skewing flatness as a global phenomenon. This geometry (positive curvature of the 3D surface of the 4-ball) is described by the 'rolling balls'.
All paths will therefore behave according to Euclidean geometry within the southern demisphere (including parallel lines and angles, with triangles totalling 180°), being locally flat as measured by a single observer. Deceptively, this impression of Euclidean flatness may appear (or be measured) as a global phenomenon throughout the universe if the action of the rolling balls is not taken into account.

Conclusion

The path of light from a celestial object is viewed by each observer in different demispheres if the object is located at a distance less than a demisphere radius from one observer, but greater than a demisphere radius from the other (*Fig.3*). Several other geometrical permutations exist for the relative viewpoints of two observers which depend on distance, whether the viewed object lies between or beyond them, and whether or not the observer or object are located within the same demisphere, but all obey the principles outlined above and may be obtained by 'rolling' the twin demispheres in 3-Dimensions around their shared equatorial surface.

[a] Only one at a time that crosses the 2D equator.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 11/15:

Back-light throughout the universe results in the curio of an inverted 'ghost universe' that surrounds each observer

Abstract

Light streams away from all celestial objects in all directions. This therefore includes back-light which travels away from an object in the opposite direction (180°) from the observer. Here we will examine how this phenomenon behaves within the observer-centric model as it generates the curious phenomenon of an unobservable 'inverse' universe.

The 'anti-CMB'

Light from an object in space travels away radially in all directions, therefore it must also travel directly away from the observer who views the object. Since the observer-centric model is a compact system we might ask, where does this 'back-light' go? As the observer looks toward a distant galaxy, back-light is on a path to re-enter the observer's southern demisphere from behind[b]. So when does this light reach the observer? The answer is: never.

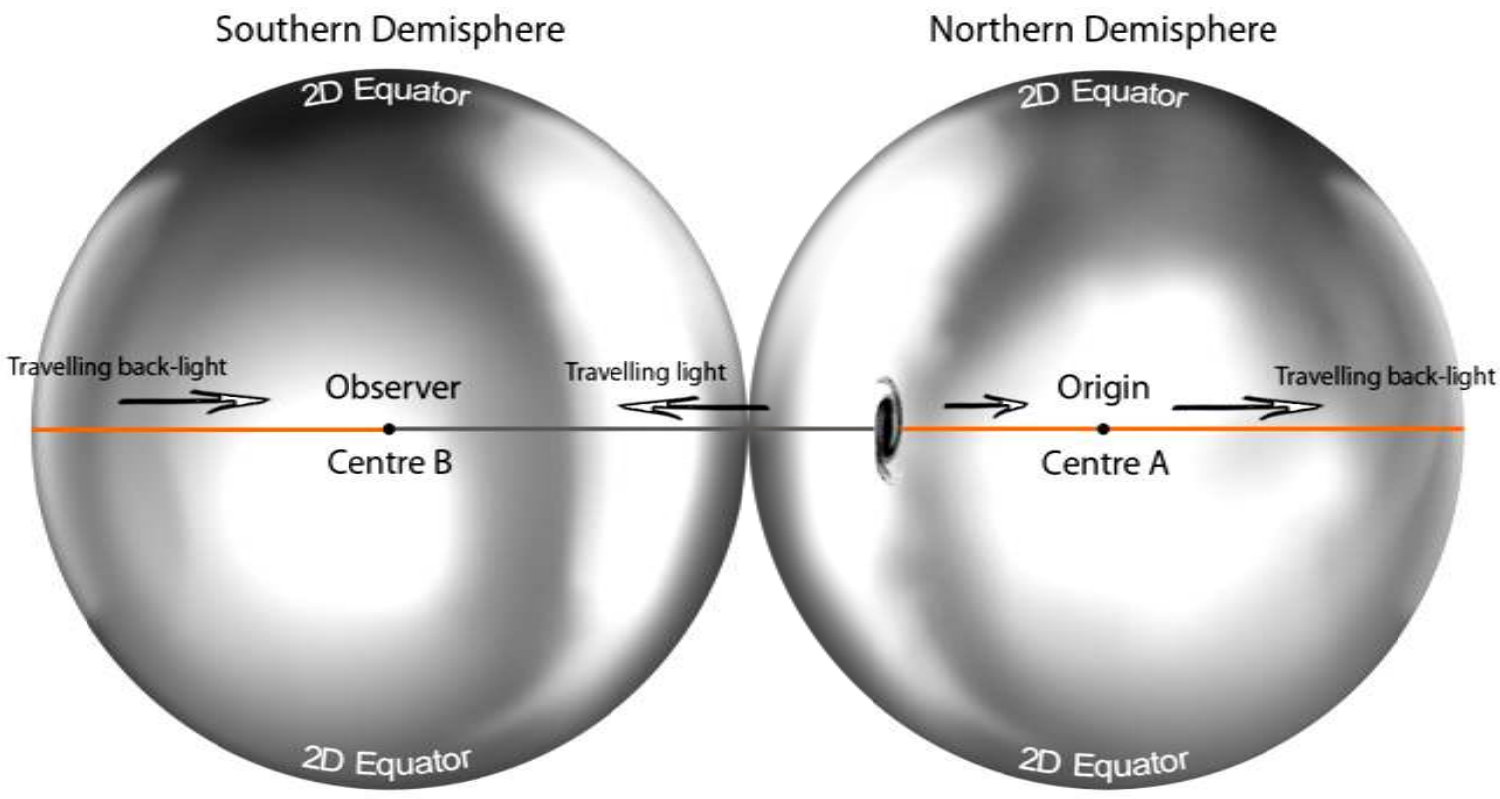

Fig.1 illustrates what does *not* happen.

The light grey line shows the back-light that streams away from a galaxy located within the observer's northern demisphere, re-entering the southern demisphere at 180° to the observer (i.e. from behind). However, since the path of back-light from the object is clearly longer than the path travelled by the CMB (which is 380,000 LY less than the look-back distance from the Big Bang origin at *Centre A* to the observer

[a] This essay was abridged from Chapter 32, *The Ghost Universe*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] See Essay 9

at *Centre B*) it can never arrive. It would require longer than the age of the universe to do so, therefore it lies beyond a cosmic horizon. For this reason, the issue of whether light is able to circumnavigate a spherically finite universe is not – as described in the *Wikipedia* article on the *Metric Expansion of Space* – an *'observational question"*[a]. It is mathematically impossible. (Scientists have searched for repeating patterns in the night sky as signs that light may have circumnavigated the universe but found none[b]. See Essay 9)

Our conventional way of looking at things is to regard the universe as *there* – like Africa is *there*, physically and immutably existent – with the observer and the photon as mere denizens of that space. However, as a 3-sphere, the observer-centric model does not permit light to act as a free agent throughout the cosmos[c]. Instead the observable universe is observed to hold the shape and size that it does because of the relationship between the origin at *Centre A* and observer at *Centre B*, with each photon playing its part as an observer occupying its own *Centre B* in keeping with Special Relativity (SR). Both the massive and the massless entity are co-sculptors of that space, 'edge-on'[d] observers from myriad centres of 3D spherical cross-sections of a 4D universe which resonates with the consistency of the principles of *Flatland*.

The ghost universe

Now let us consider what *does* happen, beginning with earliest light from the cosmic microwave-background radiation. In *Fig.2* light from the CMB leaves the point *x*:

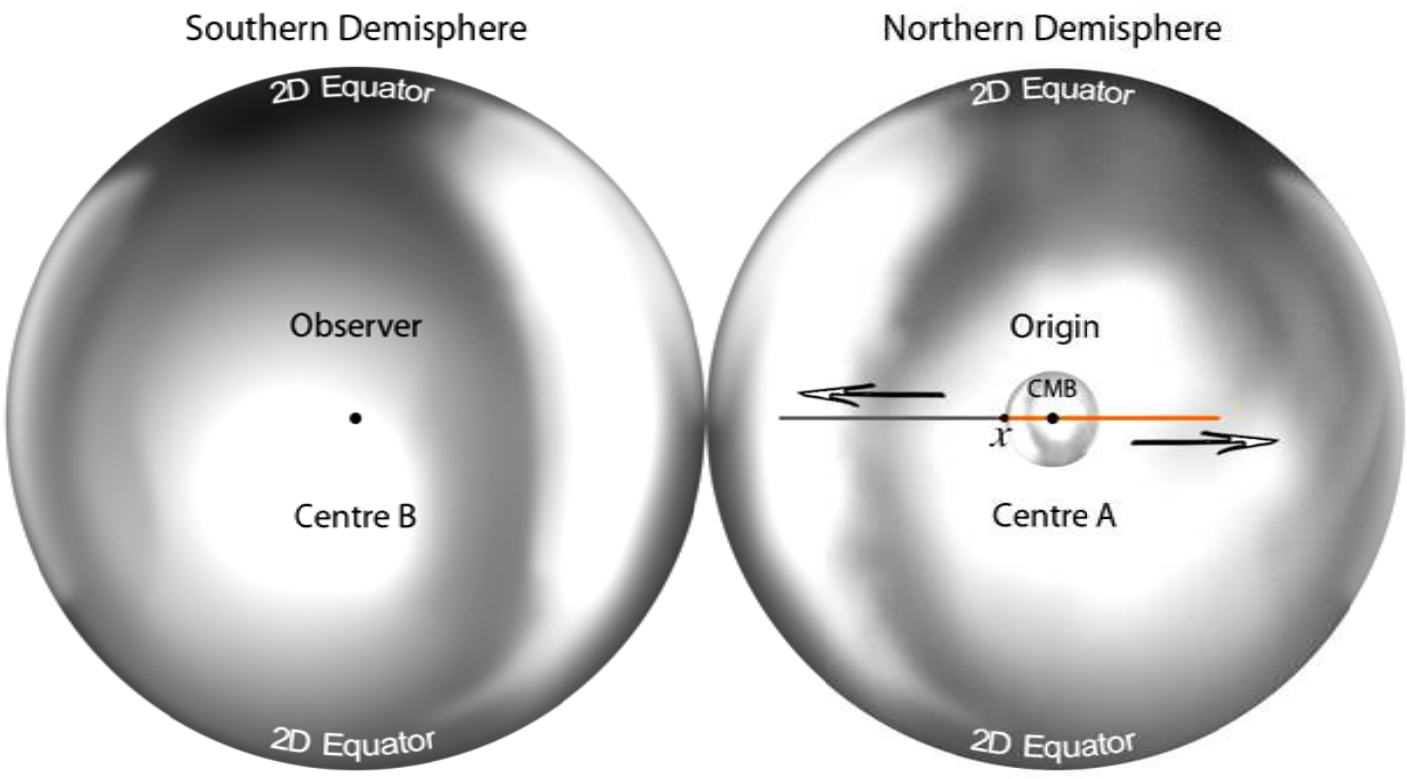

Fig.2 With scale exaggerated, the light of the CMB leaves point x at the 'surface of last scattering' 380,000 years after the Big Bang and heads toward the observer at *Centre B* (dark grey line). The light travels out in all directions, therefore it must also travel directly away from the observer at *Centre B* (light grey line), covering the same distance in the same time.

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[a] https://en.wikipedia.org/wiki/Metric_expansion_of_space - Accessed 12th Aug 2015

[b] https://arxiv.org/abs/astro-ph/0310233v1

[c] Einstein described the universe as a *'four-dimensional continuum'* [*Relativity, Appendix 5*, Routledge 2001]. As a nested hierarchy, a *Flatland*-based dimensional structure has all things made from and co-dependent on everything else. This idea is explored in Section 3 of the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

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

Because the cosmic microwave-background radiation was not released at the moment of creation but some 380,000 years later, it exists in relation to the observer as a 'tiny' spherical halo or shell around the origin at *Centre A*, which the observer at *Centre B* may only view from the outside. This shell is then viewed stretched all around the sky by the 'Antarctica effect'[a]. It therefore follows that 'back-light' from the CMB travelled out from the same point to pass through the antipodal location of *Centre A*, going on to cross the 2D equator at a point which lies at 180° to the path of the 'Penzias/Wilson' CMB we experience. However, although back-light photons are travelling toward us from every direction[b] at *c* they can never arrive, because they would have to travel a distance of an *extra* 760,000 (2 x 380,000) light years, and would therefore require a length of time equivalent to 380,000 years longer than the age of the universe to do so. As a result they lie beyond a cosmic horizon. This 'counter-shell' must now enclose the Earthbound observer as a halo of travelling radiation – a kind of 'anti-CMB'.

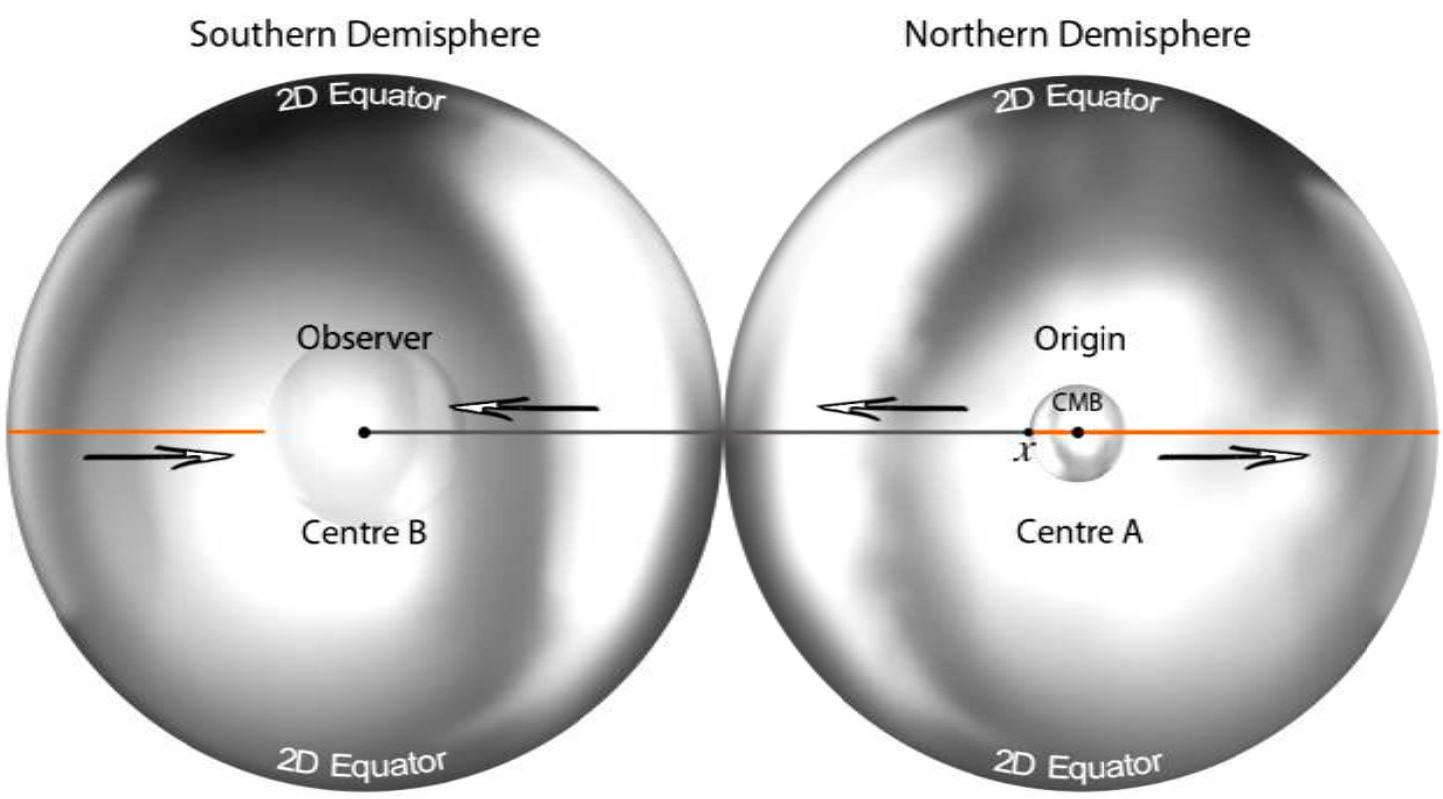

Fig.3 **The anti-CMB**. The line travelling left from *x* represents the light that arrives at the observer from the CMB. The line travelling right from *x* represents back-light from the CMB as it heads off from the same point but in the opposite direction. Back-light enters the southern demisphere but is unable to reach the observer due to ongoing *Centre A/B* recession at *c*. The spherical shell surrounding *Centre B* at a radius of 760,000 light years is the leading edge of back-light approaching the observer from the anti-CMB.

Extrapolating this geometry we discover an entire 'ghost universe' enclosing the observer comprising *all light which leaves its starting point in the opposite direction to the observer*. This light travels toward the observer at 180° from each object's currently observed position (i.e. from 'behind') with light that is never able to overtake the universe's expansion[c]. This ghost universe is 3-Dimensionally inverted with respect to the observer's *Centre B*, with every object in the universe as viewed from the back; however, as described, the light is unable to reach the observer. Although the observer-centric model renders it a geometrical reality, the ghost universe will probably remain impossible to confirm by physical observation or experiment[d] due to the restriction imposed by *c*.

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[a] See Essay 5
[b] Converging radially on the observer, having crossed the 2D equator.
[c] I.e. *Centre A/B* recession. See Essay 8
[d] Light from visible galaxies which arrives at us can never have interacted with it, because the light we see left those galaxies before the ghost universe 'arrived'.

Conclusion

The ghost universe exists as an inverse spherical image of the observable universe surrounding every observer at *Centre B*, within which light from every cosmic source as it might be viewed from the back is forever en route to the observer yet never able to arrive. Although a real phenomenon within the 3-sphere, it is likely that the ghost universe may never be confirmed empirically, and is therefore destined to remain a mathematical curio.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 12/15:

Gravitational equilibrium across the 2D equator results in a universe of net zero gravity

Abstract

The observer-centric model describes a 3-sphere observable universe in which the gravitational influence of each demisphere upon the other results in a system in equilibrium[b].

Net zero

In the model, *Centre A* and *Centre B* recede from one another at *c*, therefore it is the transfer of information relating to the position of *Centre B* relative to *Centre A* (i.e. the observer's frame of reference) which is described by *c*. Since both light and gravity propagate at *c*, the connection between them relates to this information transfer. This carries the implication that the effects of gravity have propagated over the lifetime of the universe in a similar way to light.

This phenomenon should therefore exhibit the following features:

a) As experienced by the observer at *Centre B*, gravitation should experience a form of dimensional lensing (2D equatorial lensing[c]) similar to the 'Antarctica effect' which stretches the CMB into the microwave region of the spectrum[d].
b) The 'shell' for such a phenomenon would not be at a distance of 760,000 light years around the massive observer[e], but a 'singularity's width' around every point-mass (as observer).
c) Being spherically equivalent at *Centre B*, this pull would remain undetectable by the observer (i.e. measured as zero) at the observer's location.
d) The gravitational influence of a northern demisphere would take the form of an 'anti-gravity' ('negative pressure') throughout the southern demisphere, increasing in influence spherically with respect to the observer over distance to the 2D equator.
e) Gravitational pull into the northern demisphere is equivalent at every point on the 2D equator, with reciprocal pull into the southern demisphere.
f) Because each demisphere pulls equally on the other, the system is in equilibrium.
g) The 4D global (or block) universe has therefore net zero gravitation.

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[a] This essay was abridged from Chapter 37, *Net Zero Gravitation*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] The mechanism of expansion, as described in Essay 8, is not produced by the gravity/dark energy knife-edge as currently understood, although the concept of dark energy as 'anti-gravity' (rather than an 'energy of the vacuum') may describe the gravitational influence of the observer's northern demisphere.

[c] See Essay 13

[d] See Essays 4 and 5

[e] As per the 'ghost universe' of Essay 11.

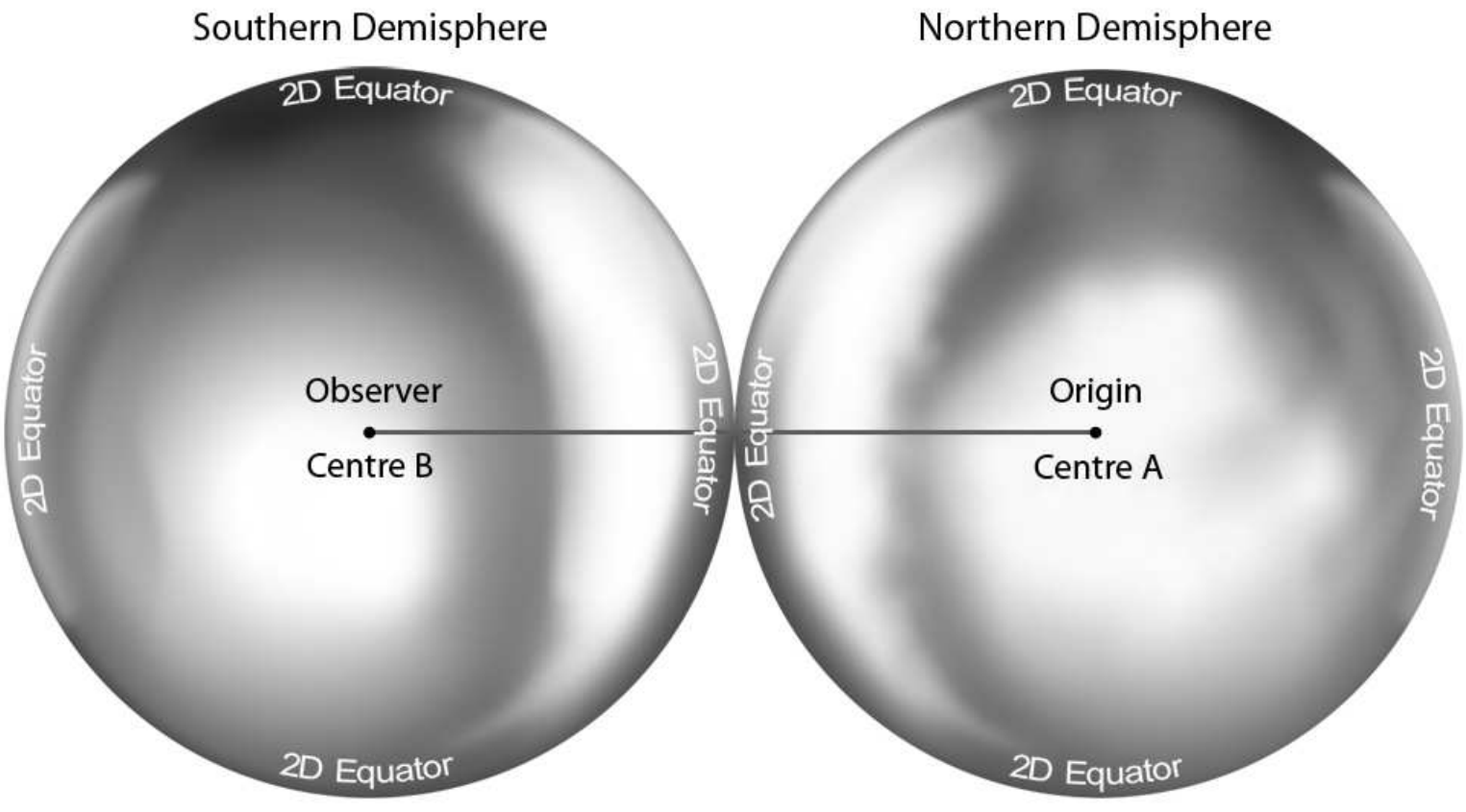

Fig.1 **Net Zero Gravitation**. Sharing a 2D equatorial surface (which is in contact at every point), the northern and southern demispheres (hemi-balls or 3-hemispheres) exist in a state of gravitational equilibrium.

Conclusion

As an aspect of the information that defines the *Centre A/B* relationship, gravity propagates between *Centre A* and *Centre B* across the 2D equator at *c*. The influence of each demisphere on the other is equivalent at the equatorial surface whilst spherical equivalence at the observer's *Centre B* location renders the pull away into the northern demisphere undetectable. The 'anti-'gravitational influence of the northern demisphere throughout the southern may account for suspected 'negative pressures' or 'dark energy'[a], whilst spherical equivalence at the observer may account for our understanding of these as *profoundly potent universe-wide, yet strangely absent in our locale*[b].

Throughout the universe gravitational pull is experienced only as a local effect[c] between point-masses[d] within a global universe of net zero gravitation. As this condition does not change over time, the universe has held this configuration at all stages of emergence from the Big Bang singularity[e].

In the observer-centric model, gravity is not 'pulling the universe to collapse'; consequently the reintroduction of Einstein's cosmological constant is not required to counteract it[f].

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[a] Although perhaps not as an 'energy of the vacuum'.

[b] This may relate to Modified Newtonian Dynamics (MOND).

[c] See Essay 14 for a fuller description of gravity as the universal outworking of *Centre B/B* propagation of information relating to *Centre A/B* recession.

[d] Due to inhomogeneous distribution (clumping of matter).

[e] As discussed in Essay 14, the observer's perception of the singularity may be a counterintuitively real dimensional effect produced by the observer's location at the centre of a universe of 'diminishing shells', the result of *Centre B/B* propagation at *c* of information relating to *Centre A/B* recession.

[f] As gravity is not 'pulling the universe to collapse' whilst being 'resisted by dark energy', these are not required to be finely balanced on a highly improbable knife-edge.

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 13/15:

2D equatorial lensing accounts for the distant Type Ia supernovae light anomaly (1998), the CIB, and the CMB as the same graduated phenomenon over distance

Abstract

In the late 1990s, two teams of astronomers[b] gathering data on Type Ia supernovae independently discovered phenomena which led them to conclude that the universe's expansion rate has changed over time. To explain this, Einstein's cosmological constant – or 'dark energy' – was reintroduced. However, empirical evidence has not been forthcoming. The observer-centric model supplies a simple alternative explanation for the light-dimming anomaly which dovetails into other distant phenomena.

The enigma

Team leader Adam Riess says of this change which occurred over a period roughly 5 to 7.5 billion years ago, *"...the Universe stopped slowing down and began to accelerate, experiencing a cosmic jerk."*[c] However, two decades and three Nobel prizes on, we are no nearer an explanation in terms of the Standard Model. In a 2012 article on the popular *Space.com*, Clara Moskowitz reflects on science's frustration with the issue: *'Scientists still don't have much of an idea why the universe is not only expanding [but] doing so ever-faster. The gravity of all the mass in the universe would be expected to pull everything back inward, so scientists call whatever force is counteracting gravity "dark energy."'* [d]

In their original 1998 paper[e] which appeared in the *Astronomical Journal*, the High-Z Supernova Search Team state in their Abstract that: *'A universe closed by ordinary matter* (i.e. $\Omega_M = 1$) *is formally ruled out…'* It is important therefore to note that data was only assessed in terms of the Standard Model, with their conclusions dependent on it being correct. So what led the teams to conclude that the universe's expansion rate is accelerating?

Standard candles

Armed with knowledge of the consistent properties of Type Ia supernovae (SNe Ia), the teams plotted redshift against apparent magnitude. UK *New Scientist* writer Sharmila Kamat summarises the independently obtained findings of both teams: *'Because the Universe is expanding, the light from the supernovae shifts towards the red end of the spectrum. The 1998 observations revealed that light from such*

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[a] This essay was abridged from Chapter 38, *2D Equatorial Lensing*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] The High-Z Supernova Search Team led by Adam Riess of the Space Telescope Science Institute and Brian Schmidt of Mount Stromlo Observatory, and the Supernova Cosmology Project led by Saul Perlmutter of Lawrence Berkeley National Laboratory.

[c] http://www.newscientist.com/article/dn4264-astronomers-date-universes-cosmic-jerk.html#.VYptzPkUVhF - Accessed 4th Dec 2016

[d] http://www.space.com/15247-universe-acceleration-dark-energy-quasars.html - Accessed 27th Sept 2015

[e] https://arxiv.org/abs/astro-ph/9805201

supernovae appeared dimmer than their red shifts predicted…'[a] After the extensive survey and analysis of 16 distant and 34 nearby supernovae, the High-Z team explain that, by a process of *'comparing the apparent magnitudes of low-redshift SNe Ia with those of their high-redshift cousins'* an unexpected discrepancy was found between the brightness and redshift of the more distant supernovae, which implied that *'The distances of the high-redshift SNe Ia are, on average, 10% to 15% farther than expected…'*

Put simply, if a supernova is dimmer than it ought to be for its redshift, both teams conclude that it must be farther away, therefore the universe's expansion rate must have changed over the light's journey, expanding differently at different times. Cosmologist John Barrow explains: *'They found that at large enough distances the expansion of the universe slowly changes gear from a state of deceleration, governed by an attractive gravitational force into one of acceleration driven by universal repulsion. This is exactly the behaviour expected of a cosmological constant.'*[b] One month before results were announced, team leader Robert Kirschner expressed serious misgivings, emailing Riess with the words, *"In your heart, you know that this is wrong"*. The reply advised, *"Approach these results not with your heart or head, but with your eyes, we are observers after all"*[c]. Good advice for the observed dimming, but does it apply to the interpretation? An interpretation which has gone on to electrify the scientific world with the 'certainty' of recent acceleration.

To explain the inferred phenomenon of recent acceleration, dark energy was introduced. Physicists Andreas Albrecht and Constantinos Skordis of UC Davis describe in a 2000 paper how *'All attempts to account for acceleration introduce a new type of matter (the "dark energy" or "quintessence").'*[d] Victoria Jaggard of *National Geographic* explains that dark energy *'is tied to quantum mechanics, which predicts that even in the vacuum of space, particles are constantly winking in and out of existence, generating energy.'*[e] 'Quintessence', in which dark energy may change over time to be either attractive or repulsive, is one of a number of models that include 'dark fluid', a model in which dark energy and dark matter are combined in a single framework.

More recent proposals explore alternatives, such as cosmologist Syksy Räsänen's theory of 'walls and bubbles', of which *Wikipedia* maintains, *'The benefit is that it does not require any new physics such as dark energy.'*[f] Alas, even Räsänen himself does not consider the model likely. Writing in 2014, science writer Stuart Clark summarises the real status of dark energy: *'There is no natural explanation for it in any current theory in physics.'*[g]

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[a] http://www.newscientist.com/article/dn4264-astronomers-date-universes-cosmic-jerk.html#.VYptzPkUVhF - Accessed 6th Oct 2015

[b] John D Barrow, *New Theories of Everything*, Oxford University Press 2008, P131

[c] Michael Brooks, *13 Things That Don't Make Sense*, Profile Books 2010, P24-25

[d] http://arxiv.org/pdf/astro-ph/9908085.pdf - Accessed 8th Jan 2017

[e] Victoria Jaggard, *Physics Nobel Explainer: Why Is Expanding Universe Accelerating? National Geographic News*, 4th Oct 2011. http://news.nationalgeographic.com/news/2011/10/111004-nobel-prize-physics-universe-expansion-what-is-dark-energy-science - Accessed 6th Oct 2015

[f] https://en.wikipedia.org/wiki/Accelerating_universe - Accessed 6th Oct 2015

[g] Stuart Clark, *The 20 Big Universe Questions*, Quercus 2014, P161

The search

Hetdex, a dark energy research collaboration between eight of the world's leading institutions[a], quote Nobel laureate Steven Weinberg on their index page: *"Dark energy is not only terribly important for astronomy, it's the central problem for physics. It's been the bone in our throat for a long time."*[b] The website continues: *'Since scientists don't know what dark energy is,.. they aren't searching for it directly – at least not yet. Instead, they will study its effect: the accelerating expansion of the universe, which has provided much of the evidence of dark energy's existence.'*[c] The project is using the world's third largest telescope to put together a 3D map of one million galaxies located between 9 and 11 BLY away. From this they understandably have high expectations. However, many professionals still express doubt. US astrophysicist Ethan Siegel asks: *'Are we sure there isn't some new type of dust or some other light-dimming property (like photon-axion oscillations) at work here?'*[d]

A brightness anomaly

With his question Siegel reminds us that the teams led by Riess and Perlmutter did not actually *discover* recent acceleration, and they did not *discover* dark energy; these are both inferred from the data. What tends to be forgotten amid all the hype is that, in fact, what the original teams found was a brightness anomaly. Siegel strives for another cause of the light-dimming, however none has been forthcoming. *Hetdex* inform us that *'the accelerating expansion of the universe…has provided much of the evidence of dark energy's existence'*. However, it must be noted that recent acceleration is not *evidence*, but was merely *posited* by the teams to explain the evidence of the brightness anomaly[e]. It remains a serious possibility that dark energy – although widely believed to comprise some 68.3% [f] of the universe – is an assumption twice removed, which would explain its stubborn and ongoing refusal to show up.

Interpretation in terms of the observer-centric model

Interestingly, both teams split the light's journey from the distant supernovae into two distinct subdivisions representing first and second phases. Max Tegmark writes that *'our Universe spent about the first half of its time decelerating, then the rest of the time accelerating.'*[g] Within the observer-centric model, this pivotal mid-point in our universe's observable history is the site of the 2-Dimensional equator which exists as the connecting surface of both demispheres. Therefore, as described in Essays 9 and 10, a major feature of the finite 3-sphere model is the ability to infer a distinction between the journeys of nearby and distant light:

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[a] University of Texas at Austin, Pennsylvania State University, Texas A&M University, Universitats-Sternwärte Munich, Leibniz Institute for Astrophysics (AIP), Max-Planck-Institut für Extraterrestrische Physik, Institut für Astrophysik Göttingen, and University of Oxford.

[b] http://hetdex.org/ - Accessed 2nd Dec 2015

[c] http://hetdex.org/dark_energy/how_find_it - Accessed 27th Sept 2016

[d] https://medium.com/starts-with-a-bang/ask-ethan-83-what-if-dark-energy-isn-t-real-dd8b0a776704#.fvvxuztvh - Accessed 25th Nov 2015

[e] Inference and evidence are not the same. If recent acceleration was inferred, it cannot logically be considered to have *'provided much of the evidence of dark energy's existence',* as *Hetdex* assert.

[f] Based on data from WMAP.

[g] Max Tegmark, *Our Mathematical Universe*, Penguin 2015, P46

- ***Nearby light*** travels to the observer through only the southern demisphere, whilst
- ***Distant light*** passes through a portion of the northern demisphere and crosses the 2D equator before continuing on the same path as nearby light through the southern demisphere.

If light from a distant object has travelled through part of the northern demisphere this should produce a small but measurable effect similar to map projection which spreads it across a region of the 2D equator that is wider than the object's original width, stretching the light's angular area so that its apparent size (as viewed by the observer) is large relative to its distance. This new phenomenon I have termed '2D equatorial lensing'. The observer views the object enlarged, projected over an angular area on the sky corresponding to its width on the 2D equator, which acts somewhat like a 'shadow boxing' screen.

This is a localised and therefore vastly scaled-down expression of the 'Antarctica effect'[a] which smears relic radiation of the CMB over the whole surface of the observer's 2D equator. As an 'everywhere-event' the angular diameter of the CMB is 360º, but the angular diameter of a galaxy must be measured in tiny fractions of arc-seconds because it occupies a particular location[b] within the universe.

To illustrate this effect (*Figs.1, 2, and 3*) I use the example of a galaxy located midway through the northern demisphere – about 10 BLY – viewed face-on and greatly exaggerated in size...

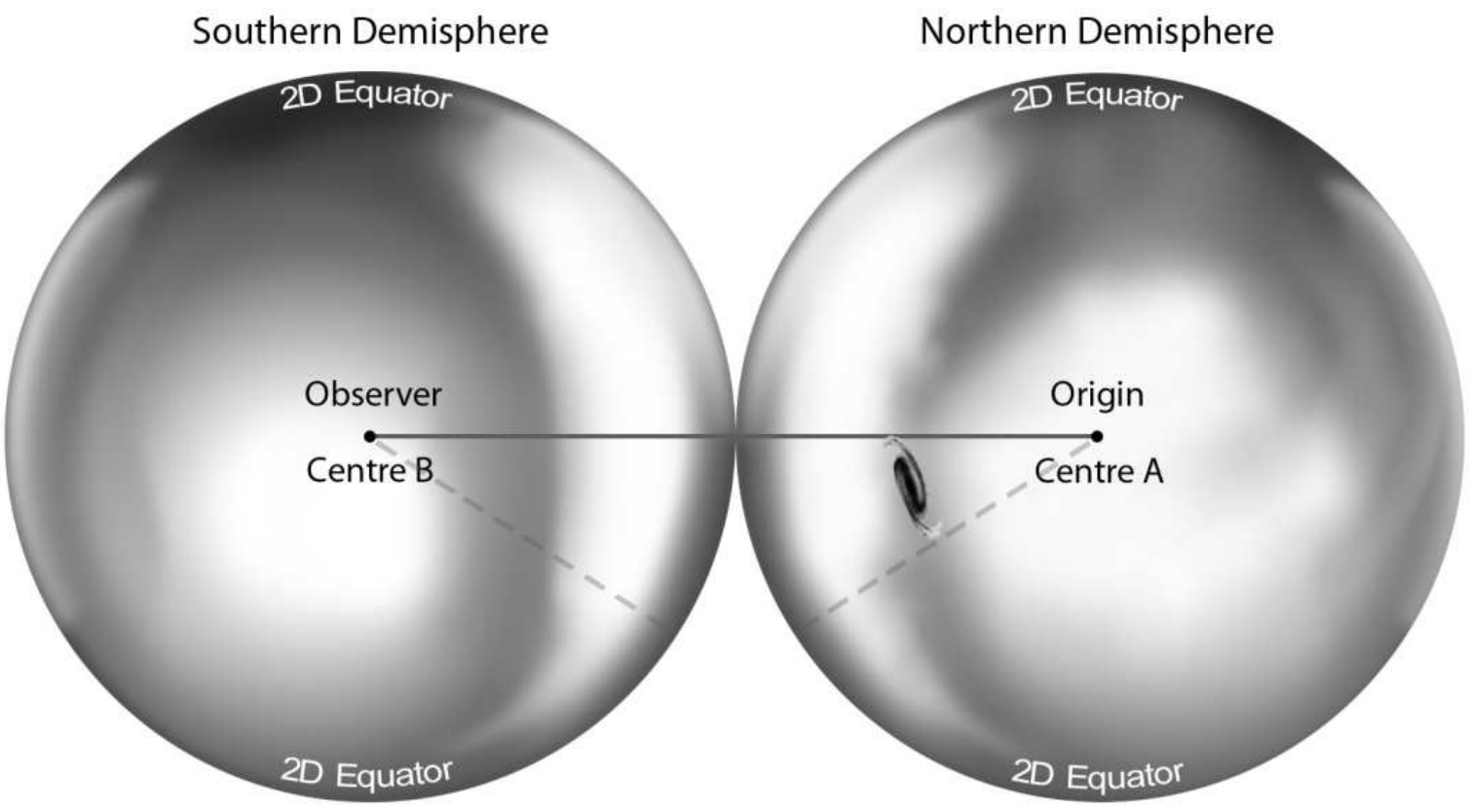

Fig.1 This shows the position in the sky of the **left edge** of the galaxy. The observer at *Centre B* views it in line with *Centre A*. We now 'roll the balls'[c]...

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[a] See Essay 4

[b] The lines that radiate to join *Centre A* to *Centre B* correspond to the lines of longitude on the Earth, joining the poles. Imagining each demisphere filled with onion skin layers, these surfaces are the 2D analogue of the 1D circles of latitude around the Earth, which similarly increase to maximum at the equator, then contract.

[c] See Essays 5, 9 and 10

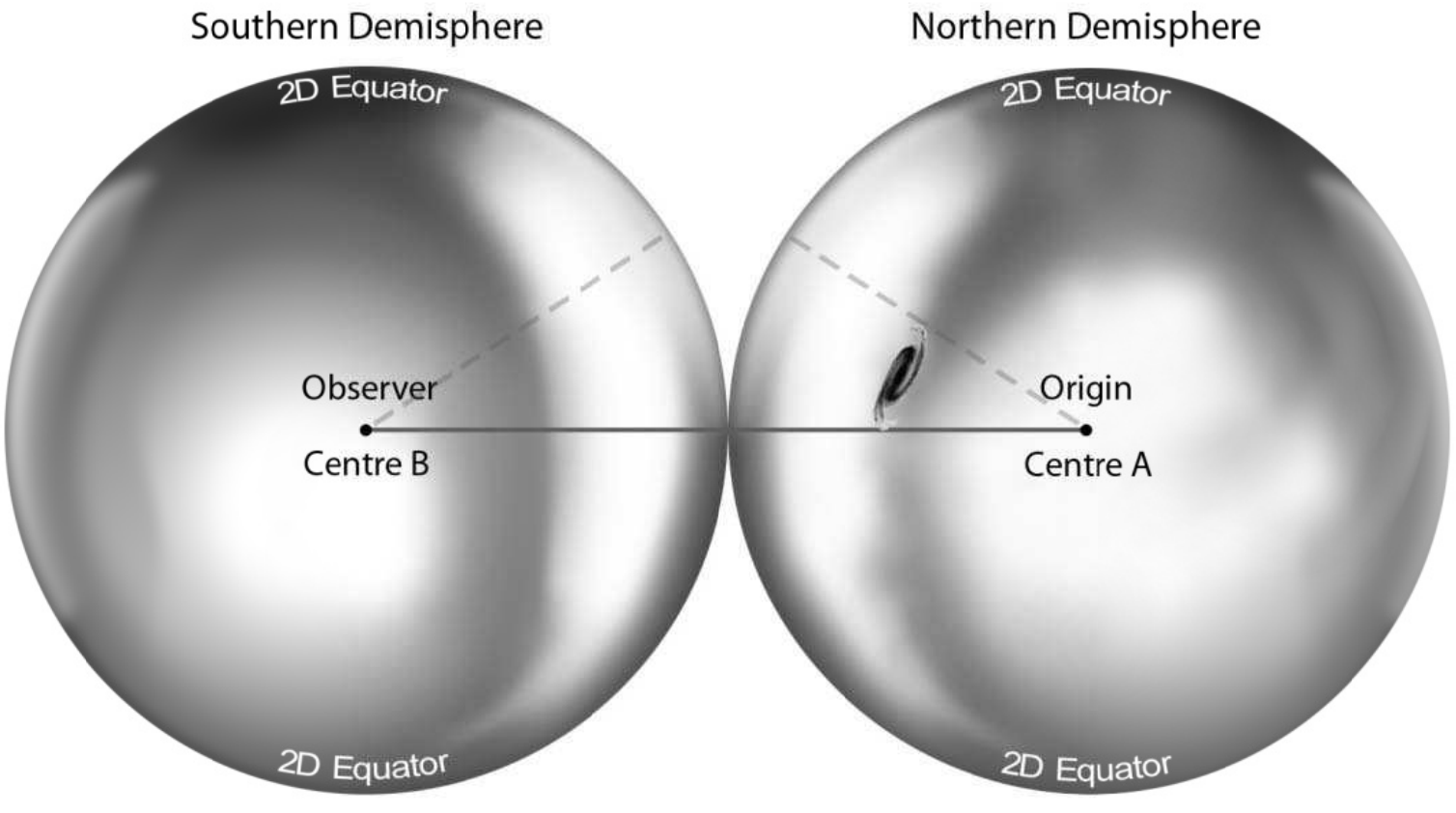

Fig.2 This shows the position in the sky of the **right edge** of the galaxy. With the demisphere surfaces in full contact the observer at *Centre B* views both edges simultaneously in line with *Centre A*. (The dotted line represents the solid line from *Fig.1*)

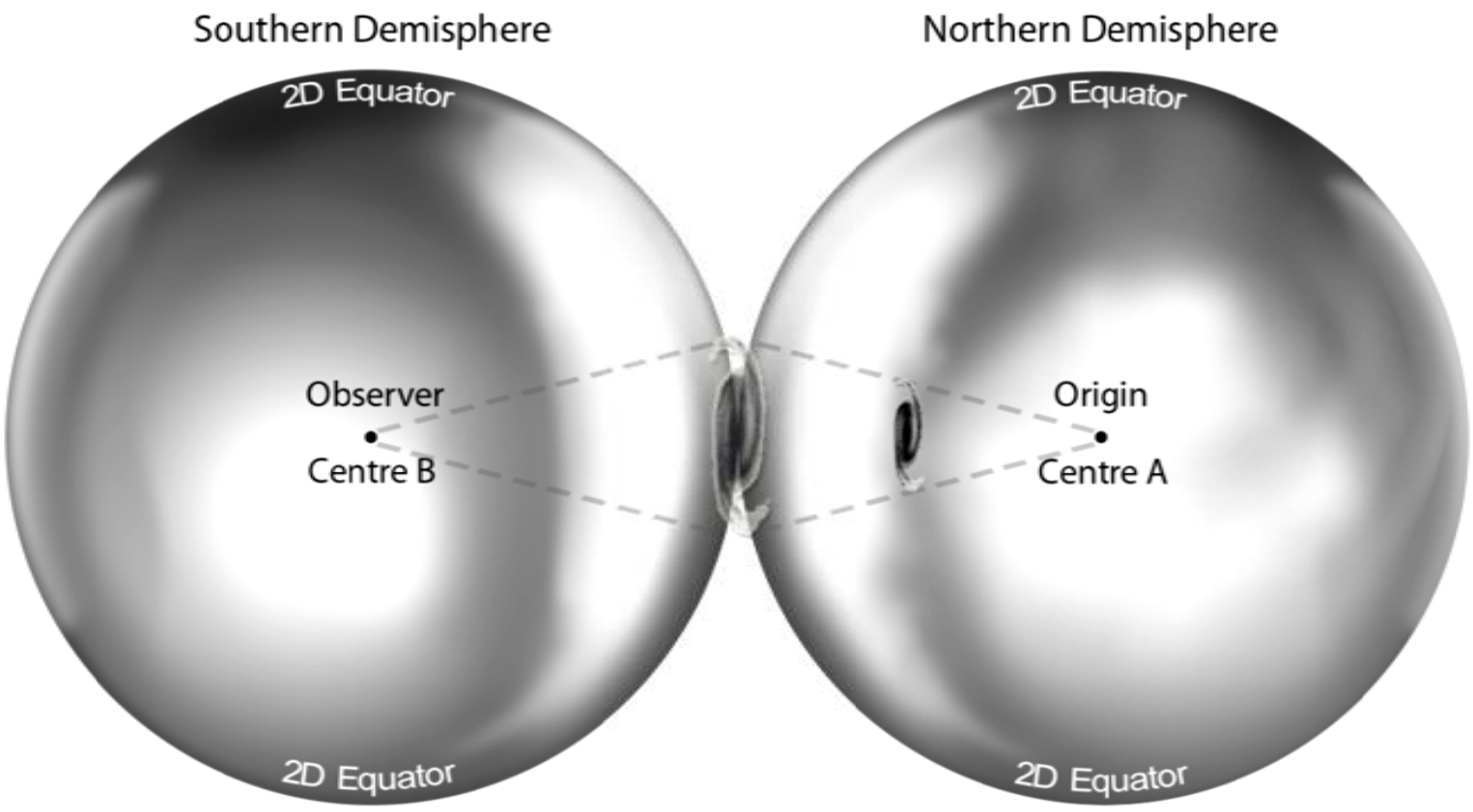

Fig.3 **2D Equatorial Lensing**. Because everything in space is in line with everything else along the *Centre A/B* axis[a], the observer at *Centre B* views the outer edges of the galaxy 'projected' onto the 2D equator as shown in Figs.1 and 2 above. Thus the observer views the galaxy magnified to the size of the projection.

2D equatorial lensing

As viewed by the observer, the galaxy's angular diameter has been magnified. Since its light has been spread over a wider area, the inverse square law (with respect to *Centre A*) causes it to appear dimmer than it

[a] In keeping with our earlier *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.

would were it not magnified. This effect (which is not merely optical but dimensional[a]) applies to everything located beyond the 2D equator and increases with distance. It is of course impossible to tell whether the luminosity of a distant object has dimmed; however, using the standard candle of the distant SNe Ia this dimming has already been observed.

Thus the observer-centric model of the universe supplies 2D equatorial lensing as a straightforward explanation for the brightness anomaly uncovered by the US teams in 1998. Consequently, there is no need to invoke changes to the expansion rate or (re)introduce a cosmological constant/dark energy, because the high-redshift SNe Ia are not farther away than expected[b].

All objects located within the observer's southern demisphere are observed from *Centre B* with no lensing[c]. Beyond the 2D equator, a distant galaxy is observed to experience an increase in angular diameter. This dimensional lensing effect increases with distance into the northern demisphere, enabling the largest of the farthest galaxies to remain visible to the observer longer than they ought. Lensing will cause them to appear increasingly diffuse, stretching the light to appear larger than they are as their redshift increases.

Online, *The Physicist*[d] describes how such an effect is observed: *'...beyond a certain distance galaxies no longer get smaller (the way things that are moving away should), instead they get redder and stay about the same size independent of distance…'*

The earliest galaxies

Astronomers have observed that the earliest galaxies behaved differently from those that came later – they were more volatile and their stars passed through their life cycles faster, releasing heavier elements into expanding space to form other stars, galaxies and ultimately us and the world around us. In a Sept 2015 report from UC Irvine on new technologies used with the Hubble Space Telescope to study the signatures of these galaxies from just 500 million years after the Big Bang, cosmologist Asantha Cooray advises: *'…these primordial galaxies were very different from the well-defined spiral and disc-shaped galaxies currently visible in the universe. They were more diffuse and populated by giant stars."*[e] And commenting on *EGS8p7 Lyman-alpha* – in 2015 the most distant galaxy observed to date – NASA Hubble Post-doctoral Scholar in Astronomy, Adi Zitrin, expressed surprise that we see it at all: *"We expect that most of the radiation from this galaxy would be absorbed by the hydrogen in the intervening space. Yet still we see Lyman-alpha from this galaxy."*[f]

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[a] Observer-centricity alters everything out there, dictating not only how it appears to us, but *what it has been through on the way to what it is to us now*. As a result, the observer may gather data (e.g. on the abundance of hydrogen, helium and lithium in the early universe) which, although now discerned through an observer-centric experience of dimensional lensing, actually happened.

[b] As 2D equatorial lensing generates redshift, it may be that age and cosmic distance need to be revisited.

[c] Whether 2D equatorial lensing exerts an influence on how light that left from within the observer's own demisphere is viewed I cannot say for certain. For simplicity I have treated it as though it does not, describing this light as 'viewed as is'.

[d] http://www.askamathematician.com/2014/03/q-how-can-the-universe-expand-faster-than-the-speed-of-light - Accessed 15th July 2015

[e] http://news.uci.edu/press-releases/parsing-photons-in-the-infrared-uci-led-astronomers-uncover-signs-of-earliest-galaxies - Accessed 15th Oct 2015

[f] http://www.theregister.co.uk/2015/09/05/farthest_away_galaxy_detected - Accessed 25th Nov 2015

No doubt the earliest galaxies were different, but these observed properties – diffusion of light, persistent visibility and stretching of the electromagnetic spectrum – are as predicted by the phenomenon of 2D equatorial lensing within the observer-centric model.

The cosmic infrared background (CIB)

From this, the most distant galaxies in our universe might be expected to exhibit exceptionally wide angular diameters across the sky with corresponding dimming, caused by the increasing angle of projection as they approach the distance of the CMB (with just behind it, *Centre A*). No record of visible light survives from that period, an era of total darkness lasting about 500 million years known as the 'cosmic dark ages' which occurred between the release of the CMB and the lighting up of the first stars. This masks the range over which the increase in dimensional lensing might be observed to go exponential.

However, a clear implication of this scenario is that there may have been *no dark ages at all* – instead just diffusion, dimming, and redshift into the range where distant light sources become visually undetectable to the observer due to their correspondingly increasing angle of projection. In their day, galaxies inhabiting the half billion year 'dark age' zone may have been just as bright in the visible spectrum as any that would follow, with extremely powerful star formation going back close to the 'last scattering'[a].

The cosmic infra-red background (CIB) is described in the general description within *Wikipedia*[b] as: *'in some ways analogous to the cosmic microwave background but at shorter wavelengths'*. And also: *'Since the CIB is an accumulated light of individual sources there is always a somewhat different number of sources in different directions in the field of view of the observer.'* The CIB must therefore represent our view of these primordial stars and galaxies – spread transparent around the sky like layers of fine filo pastry by 2D equatorial lensing, and smoothly bridging the look-back time gap between the visible spectrum and the CMB. Data from this accumulation of individual light sources occupying the frequency range between the CMB and the most distant visible objects is in clear agreement with the prediction of the observer-centric model.

In this way, 2D equatorial lensing accounts for:

- the distant Type Ia supernovae light anomaly (1998)
- the CIB, and
- the CMB

as the same graduated phenomenon over distance.

Two more astronomical phenomena may also be reinterpreted in terms of 2D equatorial lensing as follows:

- **Superluminal recession**. Within the observer-centric model nothing may exceed the constant *c* as it governs *Centre A/B* recession. Therefore the apparent superluminal recession from one another of

[a] Data published in early 2018 by Judd Bowman of Arizona State University suggests that *'stars existed... by 180 million years after the Big Bang.'* https://www.nature.com/articles/nature25792

[b] https://en.wikipedia.org/wiki/Cosmic_infrared_background - Accessed 3rd Oct 2016

distant galaxies – i.e. those located beyond the 2D equator – should also be accounted for by the observer's experience of 2D equatorial lensing.

- **Large scale structures**. At least five super-massive build-ups of matter[a] exist which appear to exceed the limit imposed by the homogeneity of the Cosmological Principle. However, since these are all at a distance of between 7-10 BLY, this would place them within the Earth-bound observer's northern (i.e. opposite) demisphere. Dimensional lensing should therefore cause their angular area to appear greater than it is.

Behind the glass curtain

Clearly, if 2D equatorial lensing along the half circumference path[b] between origin and observer stretches not merely the angular size of an object in the sky but its wavelength, it must hold profound implications for our understanding of the universe. This is particularly poignant when we consider that we observe levels of redshift which have reduced relic radiation to microwaves and a temperature marginally above absolute zero. Within the observer-centric model, two separate but connected phenomena occur together to generate the observer's experience of expansion as measured by redshift:

- *Centre A/B* recession, and
- 2D equatorial lensing

The first applies ubiquitously to the journey of all light (discussed over previous essays), whilst the second applies only to light observed to have travelled through the opposite demisphere (discussed here).

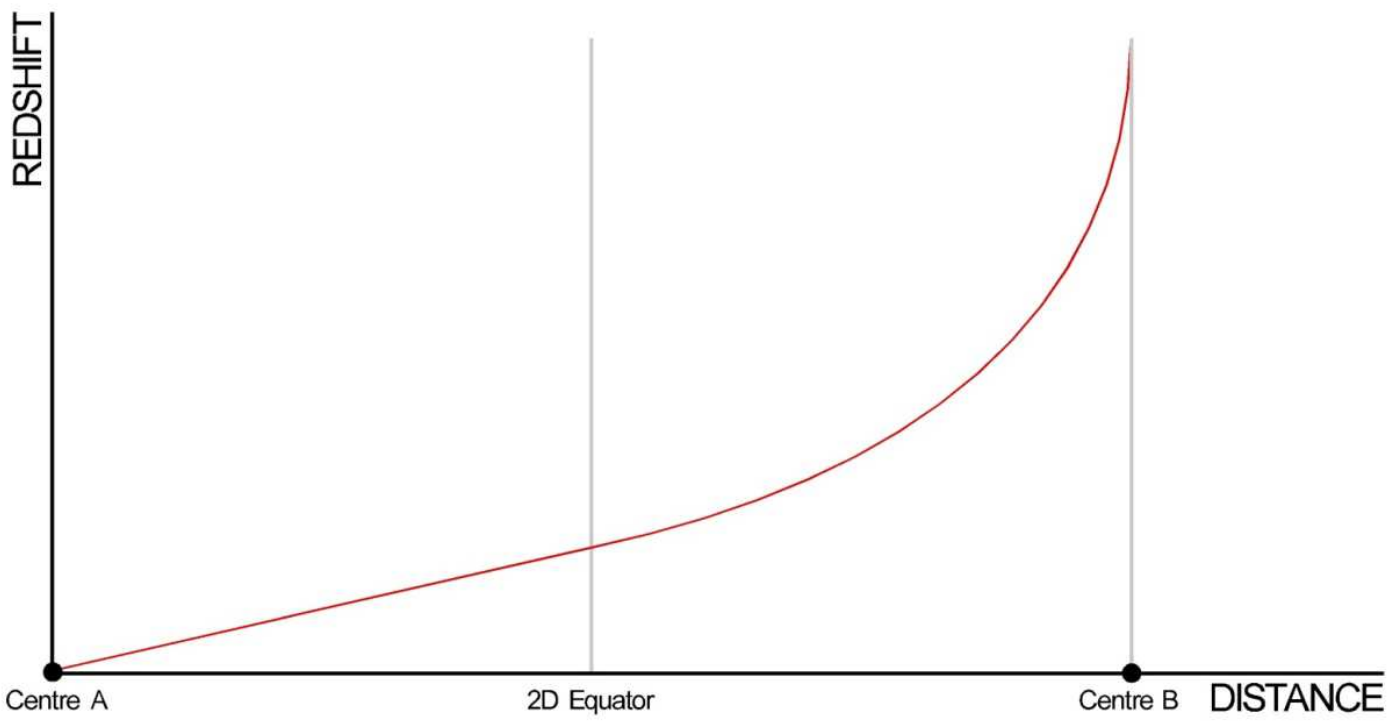

Fig.4 This curve shows the anticipated effect of distance on redshift. Redshift increases linearly between the observer at *Centre B* and the 2D equator, corresponding to the expansion of the universe due to *Centre A/B* recession at *c*. It then begins to curve due to the additional effect of 2D equatorial lensing within the northern demisphere. This observer-centric effect increases exponentially as the line approaches the origin at *Centre A*, appearing to 'emerge' from the singularity which is spread uniformly across the extreme spherical surface by the 'Antarctica effect' of 2D equatorial lensing.

[a] Hercules-Corona Borealis Great Wall, Giant GRB Ring, Huge-LQG, U1.11, and Clowes-Campusano LQG.
[b] See Essay 7

Although questions have always hung over the precise causes of redshift, nowadays we consider most distant redshift to be produced by expansion; however, if a form of 'compound redshift' is generated by the combination of expansion and dimensional lensing it may require a serious overhaul of cosmic distance and, by implication, look-back time and the age of the universe, which could conceivably be out by several billion years. Since the *Hetdex* 3D map of the observable universe out at 9 to 11 BLY is likely to be a map of a considerable portion of the inside of the northern demisphere as viewed from the southern, I would anticipate it turning up a shedload of perplexing (i.e. observer-centric) anomalies to add to the collection, all of which may find a reasonably straightforward explanation within the consistent *Flatland*-style dimensional structure from which was derived the observer-centric model of the universe.

Conclusion

Dimensional lensing across the 2D equator (2D equatorial lensing) obeys dimensional principles rather than purely optical laws because, living as we do in our reference frame at the centre of only one demisphere, the journey of distant light through both demispheres is impossible in terms of our natural 3D experience of length, width and depth[a]. The observer-centric universe is therefore not real in the straightforward objective sense with which we are familiar, but as a 3D spherical cross-section of the 4D 'hypersphere' or 4-ball, as viewed from <u>*a*</u> centre by <u>*an*</u> observer. (In accordance with the *Flatland*-derived *'Edge-On' Principle*[b]. See Essay 1)

[a] See Essays 9 and 10

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

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 14/15:

An information lag exists throughout the universe as the *Centre B/B* propagation of information relating to the *Centre A/B* recession of each point-mass, such that the universe diminishes to a singularity at *Centre A* with respect to the observer

Abstract

Within the observer-centric model the constant recession at *c* in keeping with Special Relativity of the observer at *Centre B* from the origin at *Centre A* – referred to as *Centre A/B recession* – governs both the unfolding of the universe[b] and the way that it appears to the observer[c]. However the constant *c* must also govern the relationship between each *Centre B*. Although this phenomenon – herein referred to as *Centre B/B propagation* – is a secondary effect, it describes the wider relationship of the universe to the Big Bang singularity and provides a theoretical basis for the Equivalence Principle.

At the level of point-masses

There exists a 'lag' in the propagation of information between objects throughout the universe which increases over distance[d]. This delay finds an explanation within the observer-centric model as follows: although the current *Centre A/B* state of any point-mass communicates evenly along the separation of *Centre A* and *Centre B* as they recede at *c* (between the edge of the observable universe and the observer), all *Centre B/Centre B* relationships must <u>*then*</u> propagate at the constant *c*. This means that:

- There must always exist a distance-dependent delay between the actual (current) disposition of a point-mass as described by its *Centre A/B* recession, and information relating to its experience of the *Centre A/B* recession of any other point-mass.

From the viewpoint of each point-mass at *Centre B*, the universe distributes this information as 'sections' of *Centre A/B* recession, radially in 3-Dimensions at *c*, obeying Newton's inverse square law with respect to each *Centre B*. The closer together two point-masses are, the shorter the delay as *Centre B/B* information passes between them, therefore the closer to 'identical' their *Centre A/B* relationships. Taking as an example the Sun and the Earth with each as a collection of point-masses: because the information embodied within light and gravitation takes around 8 minutes[e] to travel between them, at any given moment each point-mass *e* within the Earth experiences each point-mass *s* within the Sun (and vice versa) as possessing a *Centre A/B* relationship which is '8 minutes less receded' than it actually is. This means that the universe around each point-mass is increasingly 'out of date' with distance, relativistically at *c*.

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[a] This essay was abridged from Chapter 35, *The Information Lag*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] See Essay 7

[c] See Essay 8

[d] Varying inversely with the square of the distance between point-masses.

[e] Average of 8mins 20sec.

Obviously this is true in terms of look-back distance, but ***the Centre B/B relationship represents the entire state of the universe at every distance, spherically around every point-mass***. The information arriving at *e* tells of a universe whose maximum expansion to date is at *e* (*Centre B*, its own experience), whilst the surrounding universe is experienced as less and less expanded over distance (as a continuous series of onion-skin 'shells'). Point-mass *e* experiences point-mass *s* (and vice versa) as inhabiting a universe whose *Centre A/B* radius is 8 light minutes shorter, and since the only limit to this effect is *Centre A* itself, the diminishing universe must 'act over infinite distance' between all point-masses[a].

At the level of objects

Multiplying up the point-masses within each body this infinitesimal discrepancy becomes significant as an emergent phenomenon throughout the universe. At the macro-level of celestial objects, the Earth always 'thinks' the universe according to the Sun is smaller than it is, and vice versa, by the amount that the universe expands in 8 minutes; in other words, each experiences the other as part of a universe that is 8 minutes less expanded. The *Centre B/B* propagation of information relating to *Centre A/B* relationships may already be enshrined within Special and General Relativity as follows:

1) The point-mass is subject to Special Relativity, which describes the observer's *Centre A/B* relationship, and
2) The point-mass is also subject to General Relativity, which describes the propagation of changes in *Centre A/B* relationships throughout the universe as they effect changes in individual *Centre B/B* relationships.

Universe-wide

From this, it is a short leap to the notion that the propagation throughout the universe at *c* of *Centre B/B* information regarding *Centre A/B* recession is what <u>constitutes</u> the phenomenon of gravity. In the model, gravity does not originate at the level of objects, but is instead a tendency to draw each and every point-mass into the same location in order to iron out the discrepancy of the information lag so that the *Centre A/B* experience of each corresponds *exactly* to the *Centre B/B* experience of both.

Because all *Centre B/B* information received is 'out of date'[b] at *c*, the universe is experienced by each point-mass as less and less expanded over distance, and a massive object must therefore inhabit a universe in which other massive objects get 'smaller' in all directions. As a result, each object inhabits a 'delayed reaction' universe wherein it experiences itself as occupying a greater space than it experiences other objects as occupying, as illustrated in *Fig.1:*

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[a] Gravity is said to act over infinite distance. However, within the observer-centric model, gravity as a form of information transfer acts over the *maximum* but *finite* distance between *Centre A* and *Centre B*.

[b] Outwith a black hole; within the black hole the information lag may be closed.

Fig.1 This (greatly exaggerated) shows the way the universe appears for any two celestial objects of equal mass (bearing in mind that it is not the object *itself* which appears smaller, but the 'shell' universe it occupies). Both objects comprise a close grouping of point-masses, each of which maintains its own *Centre A/B* relationship. Because of the close proximity of each object's point-mass grouping in comparison to the distance between Object 1 and Object 2, the *Centre B/B* information lag scales up to operate universe-wide at the level of objects as an emergent phenomenon. The *Centre B/B* line between all point-mass pairs behaves as a section of the line between *Centre B* and *Centre A*, in keeping with the earlier *Pac-Man Principle*[a].

At the antipode

Because of this, another point-mass *a* located at or close to the first point-mass *e*'s antipode at *Centre A* must seem (to *e*) to inhabit a universe which has *not expanded at all*, as all massive objects now in that location are the age of the universe away with an information lag of some 13.8 billion years. All information about *a* now arriving at *e* is therefore 13.8 billion years out-of-date. Because of this, point-mass *e* within the Earth experiences information from its antipodal universe of *Centre B's* as a tiny disappearing singularity which 'dives spherically' into *Centre A*, corresponding to the compression of energy known as the Big Bang.[b]

This strangely 'point-shaped' universe is then dimensionally lensed for the observer by the 'Antarctica effect' (2D equatorial lensing[c]) across the surface of our observable universe at maximum distance in all directions – in keeping with earlier descriptions of the observer-centric universe and the, slightly later by 380,000 years, CMB.

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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] Here we encounter again the counterintuitive nature of the dimensional effect whereby, as mentioned in Essay 13, observer-centricity dictates not only how the universe appears to us, but *what it has been through on the way to what it is to us now*.

[c] See Essay 13

Information from objects currently[a] located at the antipode will arrive at *e* in 13.8 billion years' time[b], when point-mass *e* will experience that region as being as expanded as the universe *e* experiences now. Of course, point-mass *a* will no longer occupy the antipodal region, as *Centre A* will then be located at a look-back distance of 27.6 BLY (2 x 13.8) and *e* will then occupy the 'centre' of a universe that has expanded to reflect the recession of *Centre A* from *Centre B* over a look-back time of 27.6 BLY. The universe will have doubled its radius, causing information from (what is now) the current antipodal region to appear to have travelled from the 2D equator. Thus, all information that arrives at the observer from the look-back distance of the 2D equator shows the universe as it looked at $L/2$ years ago, where L represents the observer's currently experienced lifetime of the universe. In this way the 2D equatorial surface represents the universe's half-life, explaining why the universe appears to the observer to have emerged from a vanishing singularity.

As the universe expands in keeping with *Centre A/B* recession at *c*, the numbers of photons arriving at an observer (on Earth or anywhere else) from the CMB will decrease whilst the wavelength increases, eventually cooling to become the 'cosmic radio-wave background radiation'. Projecting this backward sees us immersed in the hot plasma fog at emergence through the Big Bang.

The shape of the observable universe results from a combination of relativistic expansion[c], 2D equatorial lensing[d], and the diminishing universe produced by the information lag. [*Summarised in Appendix 2*]

What about the void?

But if expansion is homogeneous[e], should such an effect not be expected to affect all volume equally, such that it ought to be volume generally, rather than mass, which exhibits gravity?

Information propagates throughout the universe at *c*, and although the information itself relates to the presence of mass, the speed at which it is observed to travel (the invariant *c*) does not. SR ordains that the photon, existing at *c*, is relativistically 'oblivious' to distance[f], but distance is a relativistic factor to the point-mass; as a result, to the observer having mass, expansion acts evenly across space[g], expressing the universe's changing state as experienced by each point-mass as observer at *Centre B*.

However, *Centre A/B* relationships are mostly concentrated within massive bodies which are themselves the product of the universe's ongoing effort to iron out the information lag and bring all *B/B* relationships into line with current *A/B* states. The inhomogeneous pattern formed by the distribution of this information throughout the cosmos in turn defines the contours of spacetime curvature. This shows why gravity may never be shielded against, because the gravitational field is a '3D map' of *Centre A/B* point-mass states as each experiences all the others, and as such merely a description of information throughout the point-mass 'matrix'.

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[a] Allowing for relativistic effects on simultaneity.
[b] By current measurements.
[c] See Essay 8
[d] See Essay 13
[e] Macroscopically throughout space; not necessarily when considered at the level of individual point-mass states.
[f] The photon's universe is length contracted to zero. However, occupying a *Centre B* and therefore maintaining its own *Centre A/B* relationship, it obeys the principles of SR.
[g] See Essay 8

Within the observer-centric model, our primeval universe would have experienced the propagation of *Centre A/B* and *Centre B/B* information in *exactly the same way that it does now*, rewinding right back into the singularity (which is a description of the observer's antipodal universe), so that gravity is no longer required to have 'distilled out' through phase changes and cooling, even if other interactions did. This accounts for gravity's long appreciated difference from the other three forces.

Equivalence

Science writer Jim Baggott writes: *'Inertial and gravitational mass are empirically identical, although there is no compelling theoretical reason why this should be so.'*[a] However, by defining them in terms of *Centre A/B* and *B/B* relations we should be able to discern a common process at work:

- ***Inertial mass:*** When a force is applied to a massive object, this constitutes an attempt to alter all its *Centre B/B* relationships with the rest of the universe, which it resists in proportion to the total amount of *Centre A/B* relationship information that would require to be changed as measured by its 'number of point-masses', or mass.
- ***Gravitational mass:*** When an object experiences the influence of a gravitational field, it is subject to an attempt by a very large grouping of point-masses to draw *each and every* point-mass into the same location, ironing out the information lag so that the *Centre A/B* experience of each corresponds *exactly* to the *Centre B/B* experience of each. As with inertial mass, this must involve a change in the total amount of *Centre A/B* relationship information within the object which is proportional to its 'number of point-masses', or mass.

From this, the underlying theoretical reason for these to be empirically identical is that both inertial and gravitational mass demand a change in the total amount of *Centre A/B* relationship information that must be communicated between every *Centre B* within the object and every *Centre B* throughout the rest of the universe[b], at *c*. The object offers up resistance (inertial) or compliance (gravitational) to this change, in proportion to its 'number of point-masses', i.e. the object's mass.

Masslessness

The information lag cannot apply to the massless particle for the reason that it and the propagation of its information always occupy the same location. The photon's riding of *Centre A/B* recession must coincide with its riding of *Centre B/B* propagation so that no delay can exist between any two photons, anywhere in the universe. In the instant that it is experienced by an observer, the photon and its observer occupy (virtually[c]) the same location[d] with respect to *Centre A*. To the point-mass there is no difference at that moment between its and the photon's experience of 'how expanded' the universe is, therefore, no lag.

Centre B/B information propagates through space at *c* for the reason that space itself is the expression of that information transfer process; i.e. of the outworking of all *Centre A/B,* and therefore *Centre B/B* relationships

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[a] Jim Baggott, *Higgs*, Oxford 2012, P4
[b] I.e. *Centre B/B* propagation.
[c] In the case of absorption of the photon, it may be that it occupies the exact same location.
[d] Relativistically

throughout the universe, as experienced at all observer locations[a]. When a photon is emitted it bears the stamp of the *Centre A/B* information of its point of emission; it then travels (with respect to all particles having mass) at *c* until it is absorbed or reflected, where it accompanies the impartation of a wealth of *Centre B/B* information from its history with respect to the observer[b].

Although the photon is viewed by the observer as *having* followed the contours of spacetime, these were not set by itself, but by all the mass-determined *B/B* information delays all around it. The massless particle exists at the same speed, *c*, as information relating to the universe's radially diminishing expansion (shells) with respect to every observer at *Centre B*, and it is this *Centre B/Centre B* information lag – interacting according to the local density of point-masses – that forms the map of spacetime curvature throughout the universe.

Conclusion

From this we may see that expansion and gravitation are indeed connected phenomena, but not as currently thought. Gravity does not 'resist' the mystery of dark energy-fuelled expansion throughout the universe, pulling the global universe to collapse[c]. Instead, it is the propagation of information at *c* (in keeping with SR) relating to the recession of *Centre A* from *Centre B* that causes our observer-centric universe to appear ever more expanded to the massive observer, with gravity as the outworking of the *Centre B* to *Centre B* information lag at *c* (in keeping with GR).

Whether or not this provides an answer to the question of what gravity is, it could never have been arrived at so long as our mechanism for expansion was based around the *action* of gravity, because the cart was preceding the horse. In the Standard Model, gravitation counter-balanced by dark energy rules the mechanism of expansion, whereas in the observer-centric model *Centre A/B* recession, accounting for expansion, rules the mechanism of gravitation. Simply by adjusting the puzzle[d], the new model – as an expression of Einstein's preferred spherical solution to the shape of the universe – allows these pieces to fall into place.

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[a] See Essay 8

[b] Of course it is not *necessary* for the massless particle to come into contact with a massive particle for the current *Centre B/B* states of all point-masses throughout the universe to propagate, otherwise gravity would be carried by light!

[c] See Essay 12

[d] The approach counselled by physicist Carlo Rovelli in *Reality is Not What It Seems*, Penguin 2017, P189

A DIMENSIONAL STRUCTURE FOR REALITY[a]

Essay 15/15:

The consistency of a *Flatland*-based dimensional structure describes a co-existence of the continuous with the discrete, within which Quantum Gravity may already have been achieved

Abstract

Efforts to unify the discrete nature of Quantum theory with the continuous nature of General Relativity have proved unsuccessful because each is already complete within its own domain. A *Flatland*-style dimensional structure holds the potential to undergird them both at a more fundamental level.

Principle and constructive theories

One of Einstein's contributions to the philosophy of science was his distinction between different *kinds* of scientific theories – first set to print in a 1919 letter to the UK *Times* – separating them into what he termed 'principle theories' and 'constructive theories'. These are described by physicist Lee Smolin as follows:

- *'A theory of principle is one that sets up the framework that makes a description of nature possible. By definition, a theory of principle must be universal… Because the world is a unity, everything interacts with everything else, and there can be only one language used to describe those interactions. Quantum theory and general relativity are both theories of principle. As such, logic requires their unification.'*
- *'The other kind of theories, constructive theories, describe some particular phenomenon in terms of specific models or equations. The theory of the electromagnetic field and the theory of the electron are constructive theories. Such a theory cannot stand alone; it must be set within the context of a theory of principle. But as long as the theory of principle allows, there can be phenomena that obey different laws.'* [b]

Quantum theory and General Relativity are both considered theories of principle, in which case they cannot both be right in their current form. In spite of this, efforts to correct them or weld them together – which have been exhaustive – have failed. Smolin paraphrases Einstein with the phrase, *'By definition, a theory of principle must be universal'* stating that *'As such, logic requires their unification'*. However, it may not be logic that requires their unification, but physicists. What logic requires is that we accept them both as constructive theories, and strive for a more 'universal' theory of principle that truly underpins them both.

The relationship between the discrete and the continuous goes to the very heart of a dimensional structure that is based on the simple and consistent geometry of EA Abbott's *Flatland: A Romance of Many*

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[a] This essay was abridged from Chapter 21, *Happy Thoughts*, and Chapter 22, *Quantum Gravity*, from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] Lee Smolin, *The Trouble With Physics*, Penguin Books 2006

Dimensions, wherein points stack to form a line; lines stack to form a plane; and so on. Here is the second *Flatland*-derived principle listed in *Appendix 1*:

> *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.**

This principle resonates with one of the fundamental problems encountered by physicists as they attempt to reconcile Quantum theory with General Relativity. With the following words, the *Wikipedia* article on Loop Quantum Gravity lists this as *Difficulty No 2:*

> *'There is the problem of reconciling the discrete combinatorial nature of the quantum states with the continuous nature of the fields of the classical theory.'*[a]

It may be that this ostensibly irreconcilable problem is in fact evidence of the solution, with Quantum theory providing a discrete description of a dimension which is one dimension lower than that described by General Relativity. The most parsimonious solution may be the geometry of dimensional stacking as embodied within the consistent principles of *Flatland*. The problem of their incompatibility vanishes when we consider that Einstein and Bohr may both have been right. As such, *grand unification is achieved by the realisation that there is no need for it*.

The *Flatland*-based dimensional structure as fundamental

A *Flatland*-based application of Dimensionality seeks to alter nothing of either Relativity or Quantum theory (whatever the implications for any other theory), but the problem of their apparent incongruity – which has its basis in the incompatibility of the mathematics of the discrete with the smooth – vanishes in the context of an *even more* fundamental model. A *Flatland*-based dimensional structure could supply such a model because, in Smolin's words, it *'sets up the framework that makes a description of nature possible'*[b]. It stands or falls as a 'theory of principle', not by the demand that it generate new empirical evidence or proof, but by its strength as an all-inclusive paradigm within which to interpret already existing science. Unification logic may be satisfied by a dimensional relationship in accordance with *Flatland*-derived principles which would allow each – Relativity and the Quantum – to describe its own domain whilst remaining in its existing form yet without contradiction. In such a scenario we might expect complete constructive theories to be separated from one another by 'domain walls' between dimensions.

Conclusion

If a simple *Flatland*-style geometrical structure undergirds reality the ongoing search for Quantum Gravity may be rendered unnecessary, because the continuous and the discrete are reconciled at a more fundamental level without the need to render them the same.

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[a] http://en.wikipedia.org/wiki/Loop_quantum_gravity - Accessed 7th Apr 2015
[b] Lee Smolin, *The Trouble With Physics*, Penguin Books 2006

I end this series of 15 essays[a] with the words from 2003 of Nobel laureate Saul Perlmutter of UC Berkeley, leader of the Supernova Cosmology Project[b], one of the teams that discovered the Type Ia supernovae brightness/redshift anomaly:

'We live in an unusual time, perhaps the first golden age of empirical cosmology. With advancing technology, we have begun to make philosophically significant measurements. These measurements have already brought surprises. Not only is the universe accelerating, but it apparently consists primarily of mysterious substances. We've already had to revise our simplest cosmological models. Dark energy has now been added to the already perplexing question of dark matter. One is tempted to speculate that these ingredients are add-ons, like the Ptolemaic epicycles, to preserve an incomplete theory. With the next decade's new experiments, exploiting not only distant supernovae, but also the cosmic microwave background, gravitational lensing of galaxies, and other cosmological observations, we have the prospect of taking the next step toward that "Aha!" moment when a new theory makes sense of the current puzzles.'[c]

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[a] Abridged from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] https://arxiv.org/abs/astro-ph/9812133

[c] http://www-supernova.lbl.gov/PDFs/PhysicsTodayArticle.pdf - Accessed 8th Jan 2017

Appendix 1

List of Dimensional Principles
Derived from FLATLAND: A Romance of Many Dimensions

by

Edwin Abbott Abbott (1884)

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.

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.

The Principle of Extension:

Each dimension is an extension in a new direction of the one below.

The Principle of Inclusion:

Each dimension includes all the ones below.

The Principle of Accessibility:

Each dimension sees and may influence all those below.

The 'Edge-On' Principle:

Each dimension is viewed from within itself one dimension lower.

The Principle of Cross-Sections:

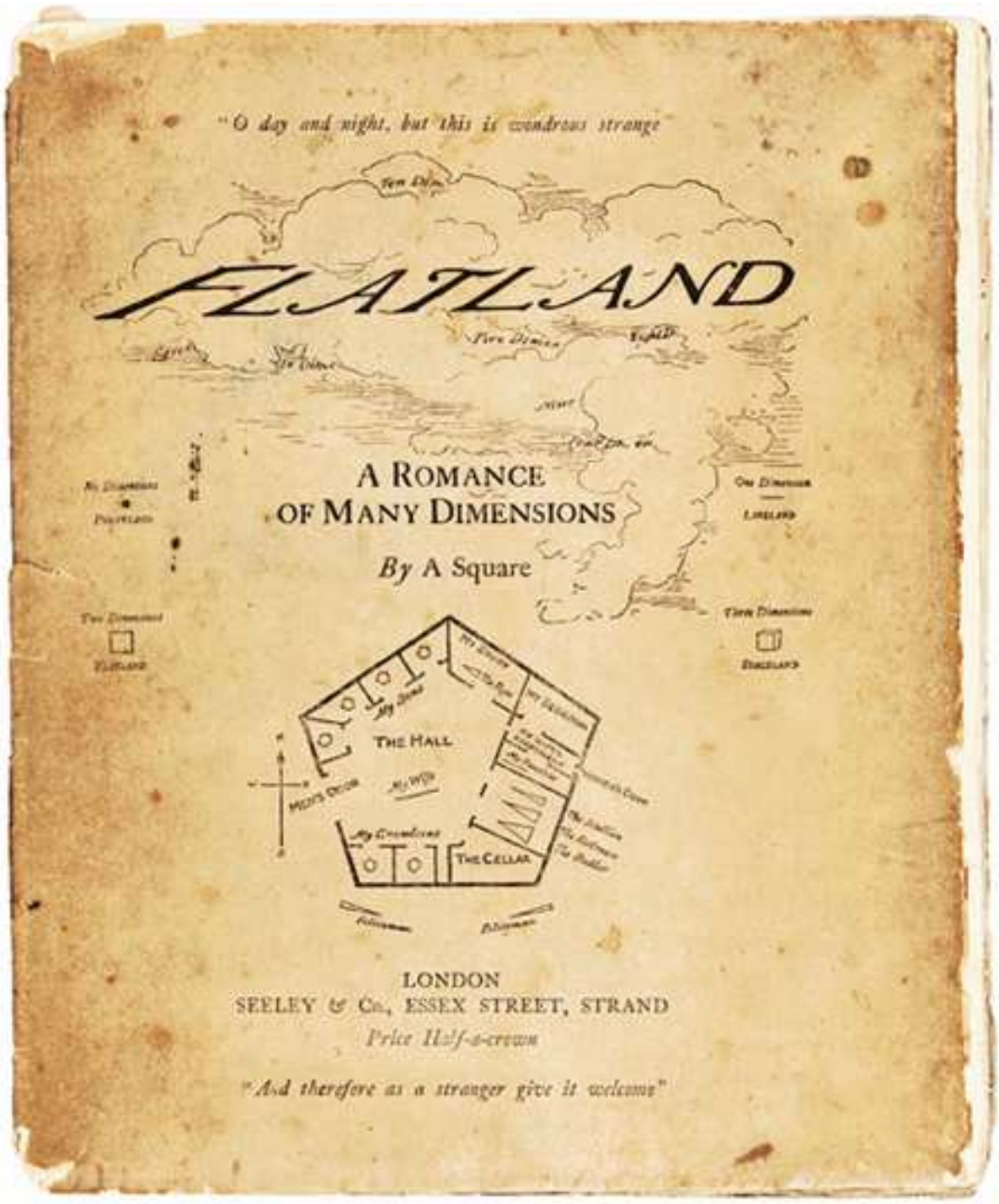
A lower dimension can experience higher dimensions only in cross-section as they pass through in consecutive slices.

The Principle of Relationship:

Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

The Principle of Viewpoints:

Any dimension may be viewed from three vantage points: from above (complete), level (`edge-on'), or below (in cross-section).



Flatland: A Romance of Many Dimensions

Edwin Abbott Abbott, 1884

(Cover to 6th Edition)

Appendix 2

The three major factors which give rise to the way the universe appears[a]

William JE Brown, Aberchirder, Scotland, 25th July 2017

Abstract: The observer-centric shape and appearance of the observable universe results from a combination of (1) relativistic expansion (i.e. information transfer between origin and observer, termed *Centre A/B recession*); (2) the 'Antarctica effect' of 2D equatorial lensing; and (3) the diminishing universe produced by the information lag (i.e. information transfer between observers, termed *Centre B/B propagation*).

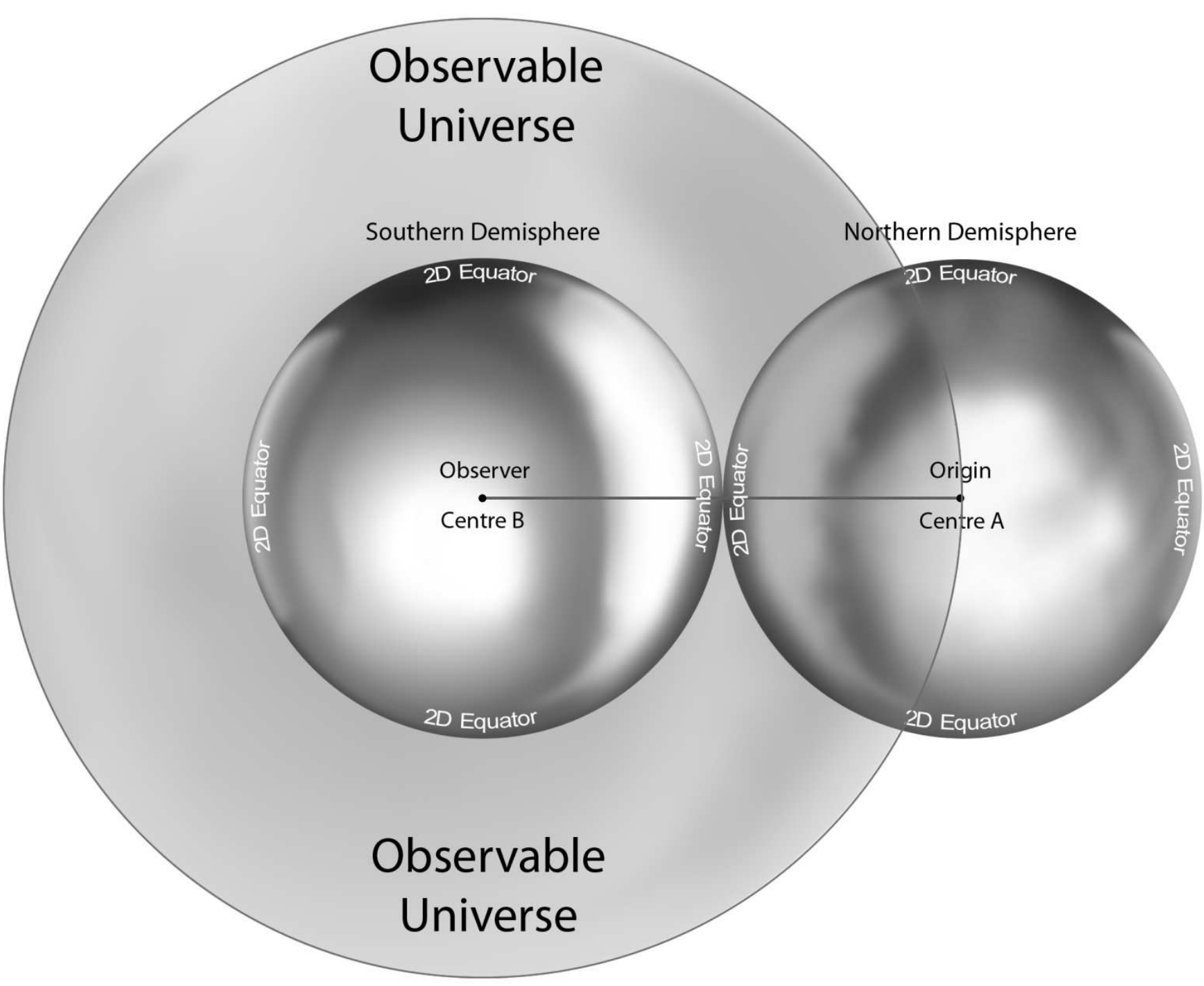


Fig.1 **The observer-centric model of the universe**[b]: With the demisphere (3-hemisphere) surfaces in full contact at every corresponding point, the lines that radiate away from and into each demisphere connect *Centres A* and *B*. The outer circle represents the distance of *Centre A* from *Centre B*, as viewed by the observer beyond the 2D equator, spherically in every direction by the 'Antarctica effect'.

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[a] Abridged from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

[b] The twin spheres are northern and southern 3-hemispheres, or hemi-balls, which divide the surface of the 4-Dimensional universe in half. To distinguish them from our accustomed Earth-style hemispheres I will use the historically redundant term, 'demispheres'.

Factor 1) Relativistic Expansion (from Essays 3 and 8)

It is essential to the whole enquiry that we permit the way that one dimension is viewed from another[a] to set the relationship between the universe as observed and the universe as is. The key is to remember that we are dealing with two very different entities which must be held in tension at all times:

- The *spherical* 3D observable universe (3-sphere), and
- The *hyperspherical* 4D block universe (4-ball).

Because space is so vast and the observable universe is *virtually* identical for any observer located in the vicinity of our Solar System, the observable universe is described, in *Wikipedia* for example, as *'centered on Earth'*[b]. Although this serves as a 'Newtonian-style' working approximation, the light sphere of the observable universe is not centred on the Earth, but the observer. Within the observer-centric model the observer corresponds to any spacetime event, located at *Centre B*, and exchange of information between the origin at *Centre A* and the antipodal observer at *Centre B* takes place in keeping with Special Relativity at the constant *c*. This exchange, termed *Centre A/B recession*[c], defines the frame of reference of each spacetime event. Expansion occurs as the relativistic expression of the observer's changing relationship at *Centre B* with antipodal origin at *Centre A*; this applies equally to the massless particle, the conscious observer, or the point-mass located at any spacetime event, so that the phenomenon of the universe's expansion is observer-centric, as shown in *Fig.2:*

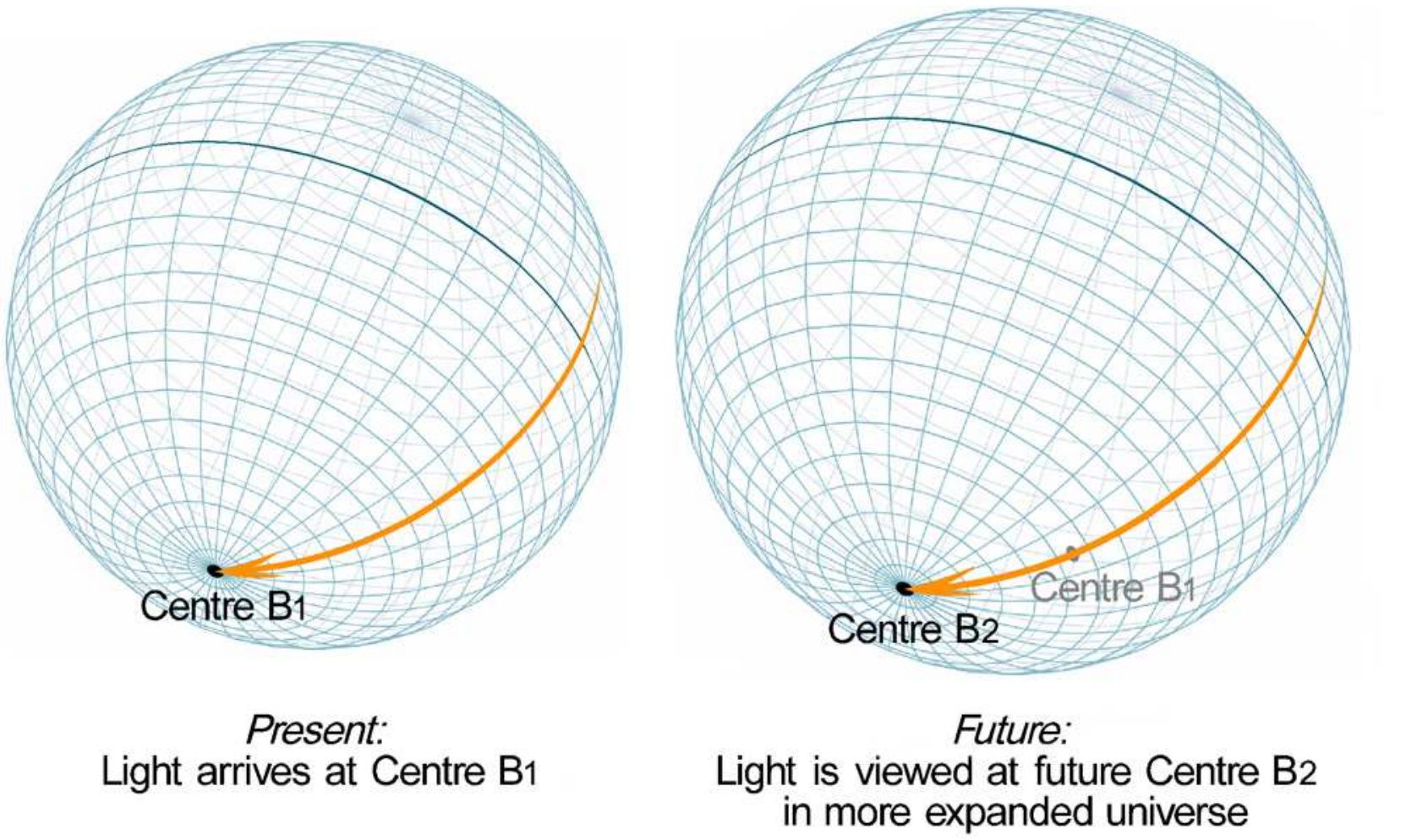

Fig.2 Shifting the analogue down by one dimension, the photon is always viewed by the observer as travelling at the same speed as the information transfer of *Centre A/B* recession. It is therefore always located at a *Centre B* which corresponds to an antipode of *Centre A*. This demonstrates how expansion of the universe takes place as the ongoing relativistic 'readjustment' of each massive observer's experience (Observer 1 at *Centre B1*, then Observer 2 at *Centre B2*) of *Centre A/B* recession in a universe which continuously requires more information to define.

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[a] See *Appendix 1* for list of *Flatland*-derived dimensional principles.
[b] https://en.wikipedia.org/wiki/Observable_universe - Accessed 2nd Aug 2015
[c] See Essay 7

From this we see that the phenomenon of expansion comprises the relativistic outworking of the ever-increasing distance that light is viewed by the observer with mass as having travelled throughout the cosmos between origin and observer (i.e. between all *Centre A's* and corresponding *Centre B's*). This necessarily increases the radius of the view, because the massive observer is the constant spectator of a universe in which light is *observed* to have travelled farther, and since the origin (*Centre A*) must always lie on the observable universe's surface[a] with the observer at its centre (*Centre B*) all observed distances within the observable sphere increase relativistically to compensate, as shown in *Fig.3:*

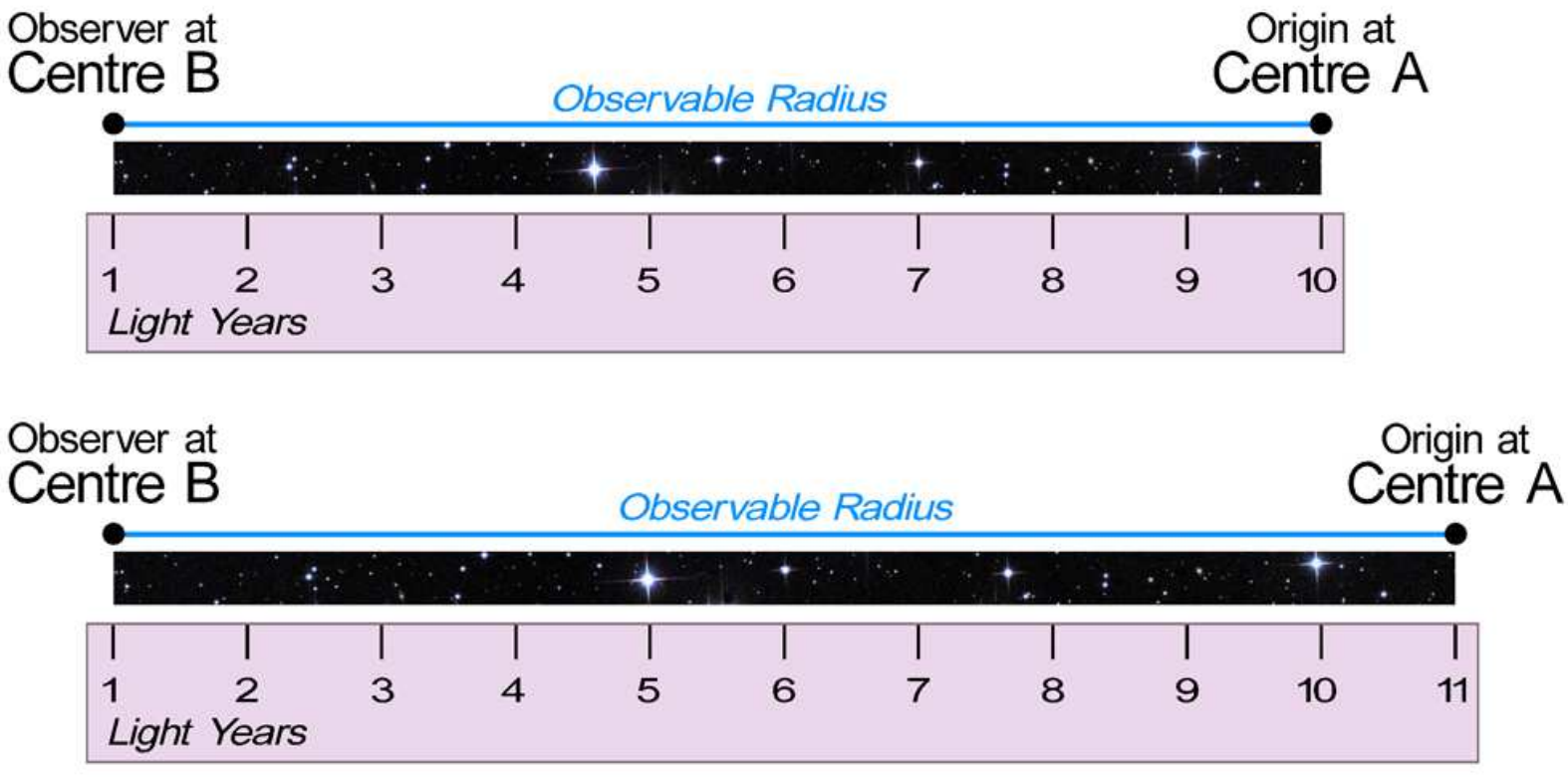

Fig.3 For the purpose of illustration we will imagine the universe to be 11 years old. A year ago it was 10 years old but light has been travelling between *Centre A* and *Centre B* for another year. As a result, relic radiation is 1 year older and the observer looks out on a universe whose observable radius has expanded (in look-back distance) by 1 light year. Because the universe is observer-centric this experience is repeated at every location in space as a *Centre B*, and all objects (observers) are now spread evenly through a radius of 11, rather than 10, light years.

Because *Centre A/B* recession obeys SR, nothing may exceed the constant *c* as it governs the unfolding of the universe. As described in Essay 4, the universe's Pac-Man topography (combined with convergence on *Centre A* within the northern demisphere) means that the 'horizon problem' of superluminal recession produced by the faster-than-light expansion of 'space itself' does not apply[b].

For all observers with mass[c], expansion throughout space is the product of the ever-increasing amount of information required to define the increasing separation at *c* in keeping with SR between each observer at *Centre B* and corresponding antipodal origin at *Centre A*.

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[a] Due to Factor 2, the 'Antarctica' effect, described here. See Essays 4 and 5

[b] The observation that 'space itself' expands whilst matter does not is explained by the relativistic nature of the interaction. As an example: the stationary observer will experience her own *Centre A/B* recession at *c* as her passage through 1 year of time, and although she herself will not physically have expanded, the radius of her universe will have expanded by 1 light year.

[c] The massless observer will not experience expansion because the information required to define expansion includes time and distance.

Factor 2) 2D Equatorial Lensing (from Essays 4, 5 and 13)

Within the observer-centric model, the mid-point in our universe's observable history is the site of the 2-Dimensional equator which exists as the connecting surface of both demispheres. Therefore, as described in Essays 9 and 10, a major feature of the finite 3-sphere model is the ability to infer a distinction between the journeys of nearby and distant light:

- ***Nearby light*** travels to the observer through only the southern demisphere, whilst
- ***Distant light*** passes through a portion of the northern demisphere and crosses the 2D equator before continuing on the same path as nearby light through the southern demisphere.

In *Elementary Topology: A Combinatorial and Algebraic Approach*[a], Donald W Blackett discusses the relationship between the northern and southern halves of a hypersphere, stating that *'the points on the equatorial sphere are left fixed'*. The behaviour of the 2-Dimensional equatorial sphere may therefore be modelled as follows:

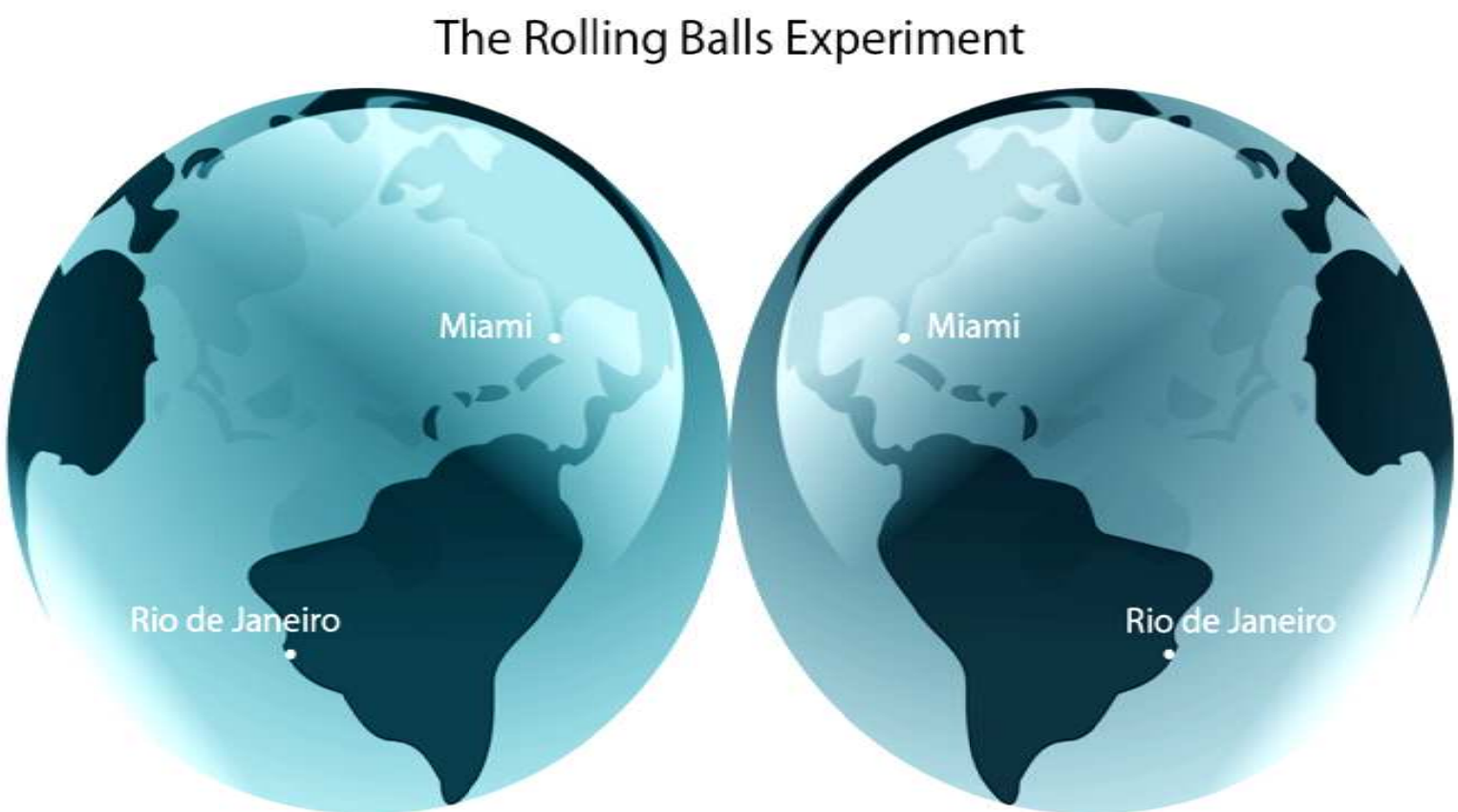

Fig.4 Take a ball to act as the globe of the Earth, then a second ball the same size which is 'printed' as a mirror image of the first. Make them touch at a specific mirrored geographical location, say Miami. Lining up the eastern seaboard of the United States we then roll them around slowly and carefully against each other. The rolling balls will always make contact at the same places – Rio to Rio, Cape Town to Cape Town, Beijing to Beijing – and no matter how much we roll them we can always return to the twin Miamis.

These twin bubbles comprise the northern and southern demispheres (3-hemispheres) which divide the *3-Dimensional* surface of our *4-Dimensional* universe, and are the analogue of the hemispheres which divide the *2-Dimensional* surface of our *3-Dimensional* Earth. By 'fixed' Blackett means Miami to Miami etc as per the 'rolling balls' experiment wherein each point on the 2D equator has the same relationship to each sphere, performing the 4-Dimensional 'trick' of joining the equatorial surfaces simultaneously at every point. This is possible because equivalent locations on the two surfaces are, where they touch, the same location.

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[a] Donald W Blackett, *Elementary Topology: A Combinatorial and Algebraic Approach*, Academic Press 1982, P198

A straight line can therefore be traced in any radial direction from the centre of either to the centre of the other, with its mid-point passing through the 2D equator. As viewed from the centre of either demisphere, everything beyond the 2D equator will appear increasingly lensed, magnified with distance. Viewed from *Centre B* of the southern demisphere, *Centre A* of the northern demisphere fills the observer's vision, appearing projected spherically around the sky in a similar way to a map projection of the Earth's surface onto a flat page which renders Antarctica the widest landmass on Earth:

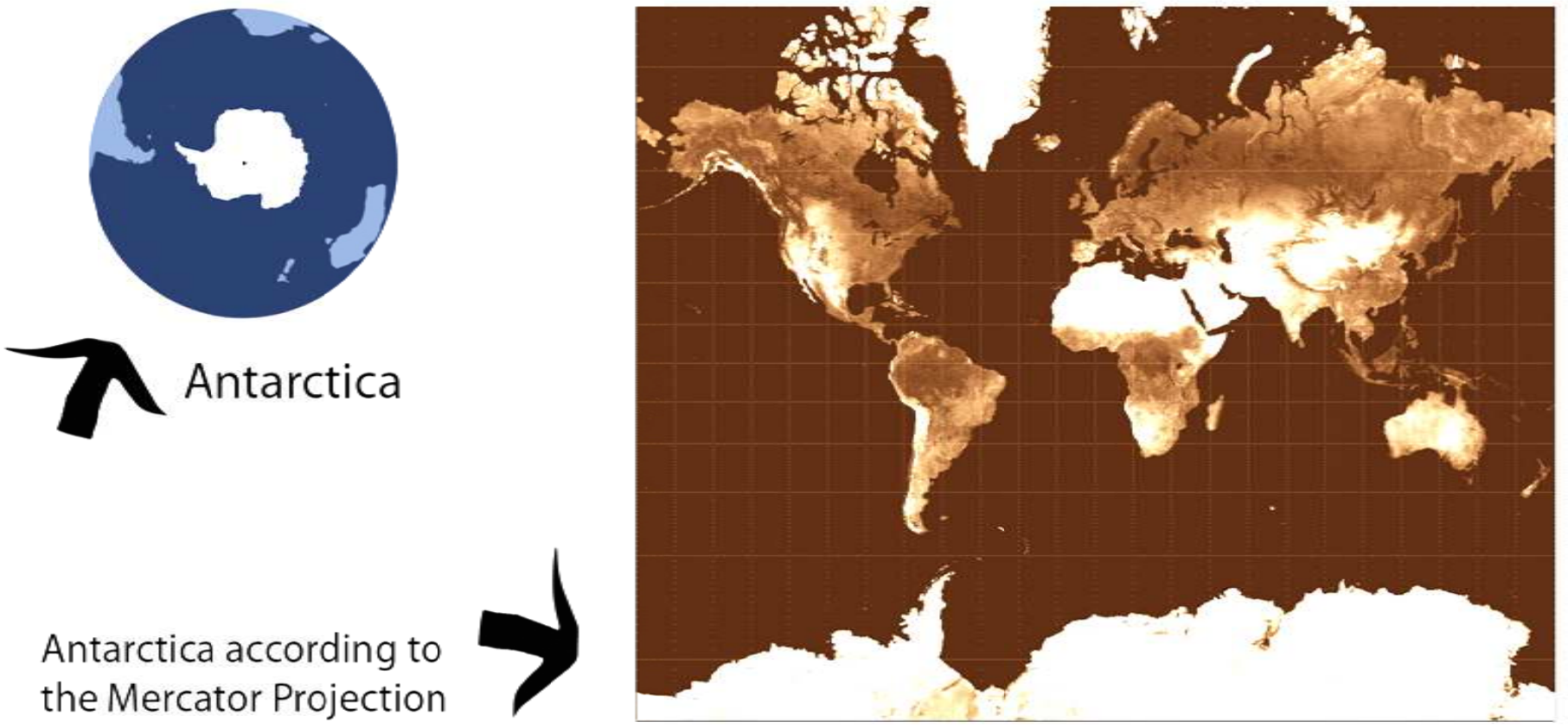

Fig.5 **The 'Antarctica effect'**. To facilitate exploration, Gerardus Mercator in 1569 rendered the spherical surface of the Earth on a flat sheet of paper, representing sailing courses of constant bearing as straight lines. His lines of longitude no longer converge at the poles but instead run parallel down the map, causing the northern and southern extremities to appear increasingly wider than they are. The 'dot' at the pole (to left) fills the whole width of the map (to right).

The 'Antarctica effect' provides a visual aid, but a more precise analogue is provided by the 'globe analogy'[a]. Professor Frank Close of Oxford University counsels us to *'Recall that Einstein's original inspiration came from the two-dimensional surface of the Earth, which is curved in a third dimension.'*[b] Thus we gain visual access to the 4th Dimension by shifting the analogue down by one dimension, picturing the 4D universe in 3D like the globe of the Earth. On this globe we now visualise the Big Bang as having occurred at the north pole, with observer at the south pole. The light's path follows the globe's 2-Dimensional surface, radiating in all directions from the north pole[c] and crossing the equator to converge at the south pole. As experienced by the observer the beams criss-cross each other and keep going[d]. In this scenario

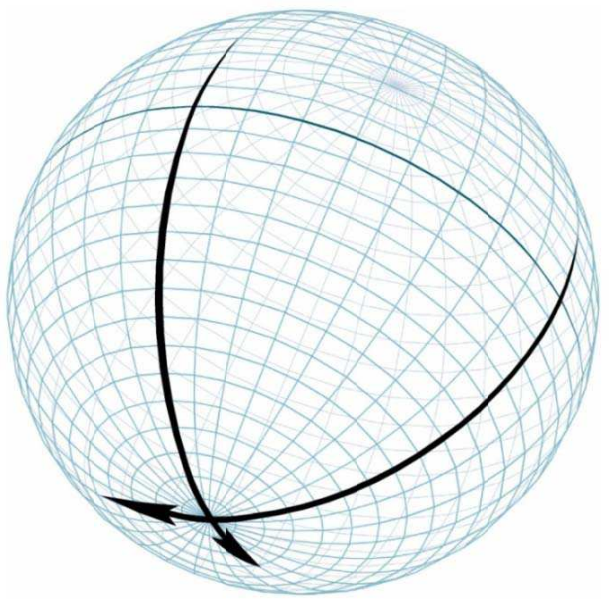

Fig.6 The globe analogy

[a] See Essay 4

[b] Frank Close, *Nothing: A Very Short Introduction*, Oxford 2009, P84

[c] In reality the CMB set out uniformly from *virtually* every point in the universe 380,000 years *after* the origin at the 'surface of last scattering', and our current position in relation to it (as a fellow object) has moved very slightly over deep time. However, as the release of the CMB was, like the Big Bang singularity itself, an everywhere-event, for our purposes we will treat this as a technicality and extrapolate theoretically right back into the origin (in relation to which the observer has not drifted).

[d] Each beam follows the path described in *Fig.2*

light beams follow the lines of longitude, tracing out (the first halves[a] of) geodesics. Although the light was released from the north pole (a single point), it is viewed from the south pole as arriving isotropically in 2D from the direction of the 1D equator.

Shifting the analogue up to 4D, although released from a single antipodal point, *Centre A*, light is viewed by the observer at *Centre B* as arriving from the direction of (i.e. having crossed) the 2D equator, converging on the observer radially in 3D. Released just 380,000 years after the Big Bang origin at *Centre A*, this 'Antarctica effect' is what gives us the impression that the cosmic microwave-background radiation (CMB) is coming at us from every direction in space because, although the light was released homogeneously near the observer's antipode at *Centre A*, it is viewed as emanating from the direction of the 2D equator, each beam having followed a line (of longitude) which is straight in 3-Dimensions. *Centre A* will therefore appear from *Centre B*[b] to be coated evenly over the inner surface of a sphere, at a distance equal to the combined radii of the twin demispheres. This new phenomenon I have termed *2D equatorial lensing*.

This is in keeping with observation of the CMB, which converges spherically on the observer from all directions in the sky. The uniformity of temperature displayed by the CMB is consistent with it having been released within such a causal area, near *Centre A*, eliminating current problems with superluminality. Without the need for any form of inflationary 'burst' event, the globe analogy provides a straightforward explanation for:

1) The omni-directionality of the CMB, and
2) The smooth homogeneity of the CMB.

Distant objects

This scenario holds implications for all distant objects which, unlike the CMB, are localised in space. If light from a distant object has travelled through part of the northern demisphere this should produce a small but measurable effect which spreads it across a region of the 2D equator that is wider than the object's original width, stretching the light's angular area so that its apparent size (as viewed by the observer) is large relative to its distance. The observer thus views the object as enlarged, projected over an angular area on the sky corresponding to its width on the 2D equator, which acts somewhat like a shadow boxing screen.

This is a localised and therefore vastly scaled-down expression of the 'Antarctica effect'[c] which smears relic radiation of the CMB over the whole surface of the observer's 2D equator. As an 'everywhere-event' the angular diameter of the CMB is 360º, but the angular diameter of a galaxy must be measured in tiny fractions of arc-seconds because it occupies a particular location[d] within the universe. To illustrate this effect (over *Figs.7, 8, 9*) I use the example of a galaxy located midway through the northern demisphere – about 10 BLY – viewed face-on and greatly exaggerated in size:

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[a] Light cannot circumnavigate the 3-sphere universe, as relic radiation has always travelled a retrospective half-circumference with respect to the observer. See Essay 7

[b] And theoretically vice versa, although, because the phenomenon is observer-centric the observer must always occupy *Centre B*.

[c] See Essay 4

[d] The lines that radiate to join *Centre A* to *Centre B* correspond to the lines of longitude on the Earth, joining the poles. Imagining each demisphere filled with onion skin layers, these surfaces are the 2D analogue of the 1D lines of latitude around the Earth, which similarly increase to maximum at the equator, then contract. See Essay 6

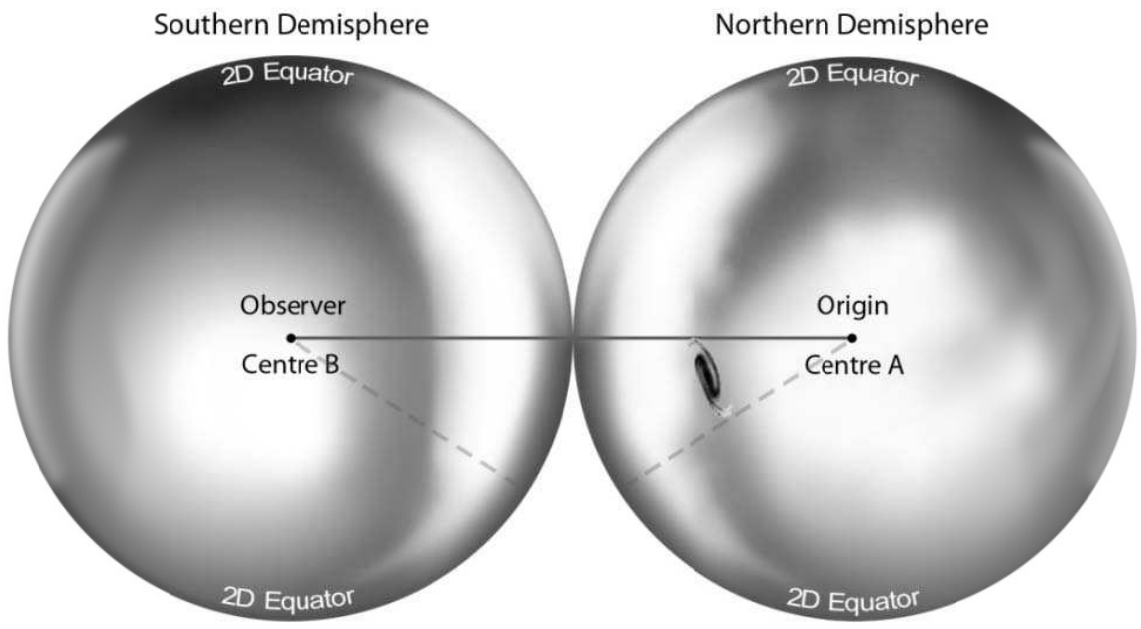

Fig.7 This shows the position in the sky of the **left edge** of the galaxy. The observer at *Centre B* views it in line with *Centre A*. We now 'roll the balls'.

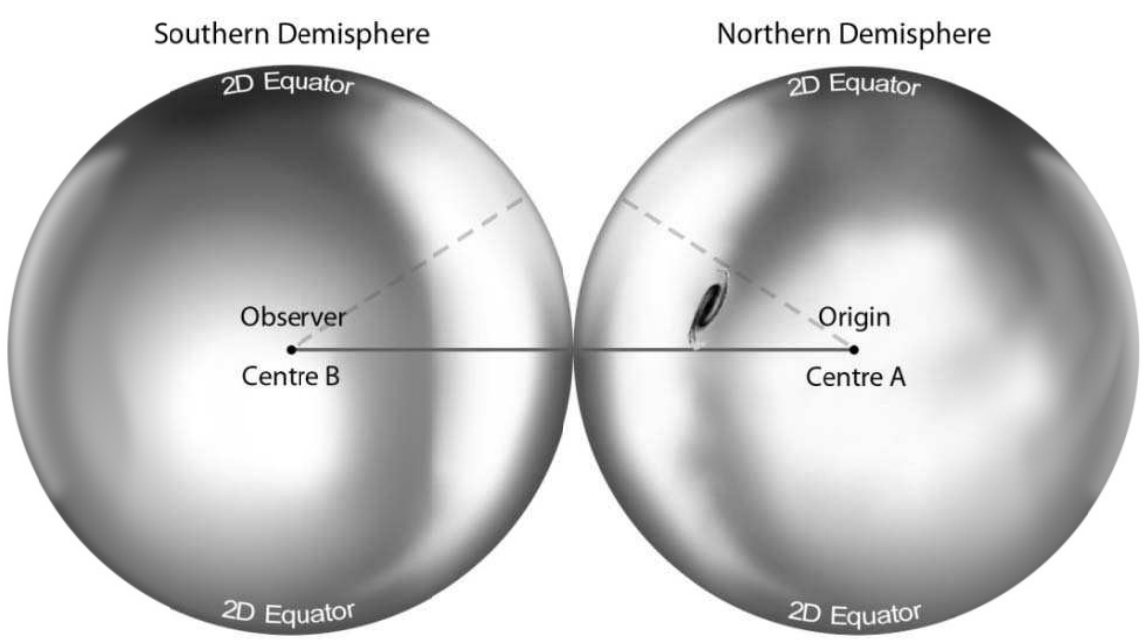

Fig.8 This shows the position in the sky of the **right edge** of the galaxy. With the demisphere surfaces in full contact the observer at *Centre B* views both edges simultaneously in line with *Centre A*. (The dotted line represents the solid line from *Fig.7*)

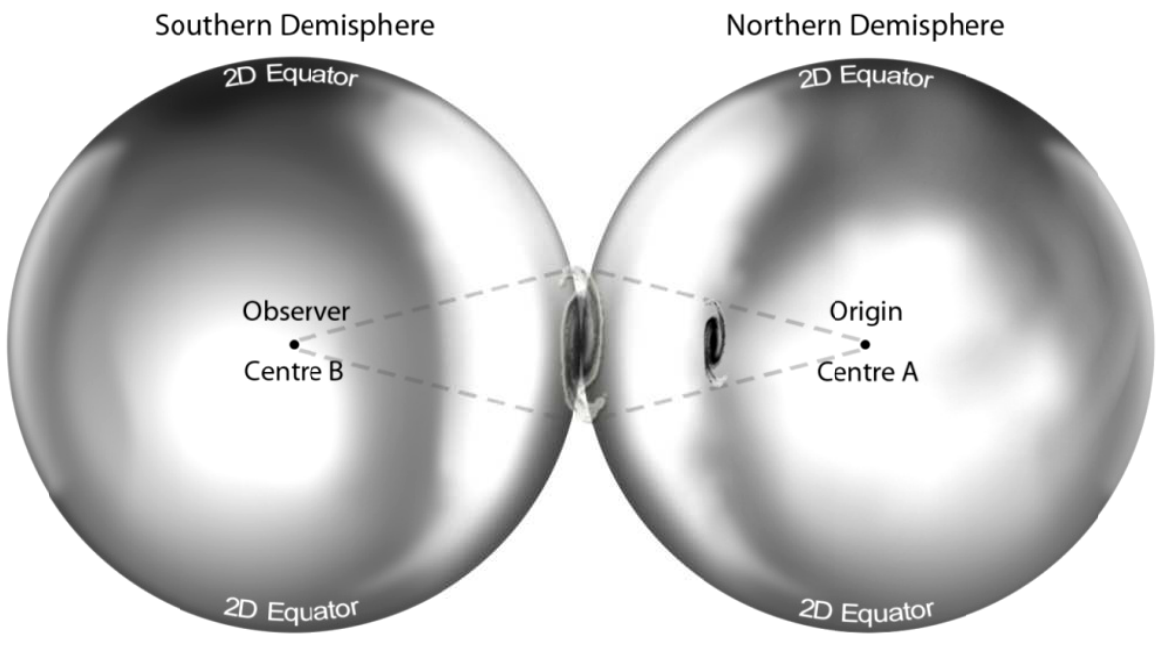

Fig.9 **2D Equatorial Lensing**. Because everything in space is in line with everything else along the *Centre A/B* axis[a], the observer at *Centre B* views the outer edges of the galaxy 'projected' onto the 2D equator as shown in *Figs.7* and *8* above. Thus the observer views the galaxy magnified to the size of the projection.

[a] In keeping with the earlier *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.

As viewed by the observer, the galaxy's angular diameter has been magnified. Since its light has been spread over a wider area, the inverse square law (with respect to *Centre A*) causes it to appear dimmer than it would were it not magnified. This dimensional effect applies to everything located beyond the 2D equator and increases with distance.

It is of course impossible to tell whether a galaxy's luminosity has dimmed; however, using the standard candle of the distant SNe Ia this dimming has already been observed. Thus the observer-centric model of the universe supplies 2D equatorial lensing as a straightforward explanation for the brightness anomaly[a] uncovered by the two US teams[b] in 1998. Consequently, there is no need to invoke changes to the expansion rate or (re)introduce a cosmological constant/dark energy, because the high-redshift SNe Ia are not farther away than expected[c].

All objects located within the observer's southern demisphere are observed from *Centre B* with no lensing[d]. Beyond the 2D equator, a distant object must experience an observed increase in angular diameter. This dimensional lensing effect increases with distance into the northern demisphere, enabling the largest of the farthest galaxies to remain visible to the observer longer than they ought. Lensing must cause them to appear increasingly diffuse, stretching the light to appear larger than they are as their redshift increases. Online, *The Physicist*[e] describes how such an effect is observed: *'...beyond a certain distance galaxies no longer get smaller (the way things that are moving away should), instead they get redder and stay about the same size independent of distance…'*

Astronomers have observed that the earliest galaxies behaved differently from those that came later – they were more volatile and their stars passed through their life cycles faster, releasing heavier elements into expanding space to form other stars, galaxies and ultimately us and the world around us. In a Sept 2015 report from UC Irvine on new technologies used with the Hubble Space Telescope to study the signatures of these galaxies from just 500 million years after the Big Bang, cosmologist Asantha Cooray advises: *'...these primordial galaxies were very different from the well-defined spiral and disc-shaped galaxies currently visible in the universe. They were more diffuse and populated by giant stars.'*[f] And commenting on *EGS8p7 Lyman-alpha* – in 2015 the most distant galaxy observed to date – NASA Hubble Post-doctoral Scholar in Astronomy, Adi Zitrin, expressed surprise that we see it at all: *"We expect that most of the radiation from this galaxy would be absorbed by the hydrogen in the intervening space. Yet still we see Lyman-alpha from this galaxy."*[g]

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[a] UK *New Scientist* writer Sharmila Kamat summarises the independently obtained findings of both teams: *'The 1998 observations revealed that light from [distant] supernovae appeared dimmer than their red shifts predicted…'* http://www.newscientist.com/article/dn4264-astronomers-date-universes-cosmic-jerk.html#.VYptzPkUVhF - Accessed 6th Oct 2015

[b] The High-Z Supernova Search Team led by Adam Riess of the Space Telescope Science Institute and Brian Schmidt of Mount Stromlo Observatory, and the Supernova Cosmology Project led by Saul Perlmutter of Lawrence Berkeley National Laboratory.

[c] As 2D equatorial lensing produces redshift, it may be that age and cosmic distance need to be re-evaluated.

[d] Whether 2D equatorial lensing exerts an influence on how light that left from within the observer's own demisphere is viewed I cannot say for certain. For simplicity I have treated it as though it does not, describing this light as 'viewed as is'.

[e] http://www.askamathematician.com/2014/03/q-how-can-the-universe-expand-faster-than-the-speed-of-light - Accessed 15th July 2015

[f] http://news.uci.edu/press-releases/parsing-photons-in-the-infrared-uci-led-astronomers-uncover-signs-of-earliest-galaxies - Accessed 15th Oct 2015

[g] http://www.theregister.co.uk/2015/09/05/farthest_away_galaxy_detected - Accessed 25th Nov 2015

No doubt the earliest galaxies were different, but these observed properties – diffusion of light, persistent visibility, and stretching of the electromagnetic spectrum – are as predicted by the phenomenon of 2D equatorial lensing within the observer-centric model.

The cosmic infrared background (CIB)

From this, the most distant galaxies in our universe might be expected to exhibit exceptionally wide angular diameters across the sky with corresponding dimming, caused by the increasing angle of projection as they approach the distance of the CMB (with just behind it, *Centre A*). No record of visible light survives from that period – an era of total darkness lasting about 500 million years known as the 'cosmic dark ages' which occurred between the release of the CMB and the lighting up of the first stars. This masks the range over which the increase in dimensional lensing might be observed to go exponential.

However, a clear implication of this scenario is that there may have been *no dark ages at all* – instead just diffusion, dimming, and redshift into the range where distant light sources become visually undetectable to the observer due to their correspondingly increasing angle of projection[a]. The cosmic infra-red background (CIB) must therefore represent our view of these primordial stars and galaxies – spread transparent around the sky like layers of fine filo pastry by 2D equatorial lensing, and smoothly bridging the look-back time gap between the visible spectrum and the CMB.

In the general description within *Wikipedia*[b], the CIB is described as: *'in some ways analogous to the cosmic microwave background but at shorter wavelengths'*. And also: *'Since the CIB is an accumulated light of individual sources there is always a somewhat different number of sources in different directions in the field of view of the observer.'* Data from this accumulation of individual light sources – occupying the frequency range between the cosmic microwave-background and the most distant visible objects – is in clear agreement with the prediction of the observer-centric model.

Two more astronomical phenomena may also be interpreted in terms of 2D equatorial lensing as follows:

- **Superluminal recession**. Within the observer-centric model nothing may exceed the constant *c* as it governs *Centre A/B* recession. Therefore the apparent superluminal recession from one another of distant galaxies – i.e. those located beyond the 2D equator – must also be accounted for by the observer's experience of 2D equatorial lensing.

- **Large scale structures**. At least five super-massive build-ups of matter[c] exist which appear to exceed the limit imposed by the homogeneity of the Cosmological Principle. However, since these are all at a distance of between 7-10 BLY, this should place them within the Earth-bound observer's northern (i.e. opposite) demisphere. Dimensional lensing will therefore cause their extent to appear greater than it is.

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[a] Data published in early 2018 by Judd Bowman of Arizona State University suggests that *'stars existed... by 180 million years after the Big Bang.'* https://www.nature.com/articles/nature25792

[b] https://en.wikipedia.org/wiki/Cosmic_infrared_background - Accessed 3rd Oct 2016

[c] Hercules-Corona Borealis Great Wall, Giant GRB Ring, Huge-LQG, U1.11, and Clowes-Campusano LQG.

Clearly, if 2D equatorial lensing along the half circumference path[a] between origin and observer stretches not merely the angular size of an object in the sky but its wavelength, it must hold profound implications for our understanding of the universe. This is particularly poignant when we consider that we observe levels of redshift which have reduced relic radiation to microwaves and a temperature marginally above absolute zero.

Within the observer-centric model therefore, two separate but connected phenomena occur together to generate the observer's experience of expansion as measured by redshift:

- *Centre A/B* recession, and
- 2D equatorial lensing

The first applies ubiquitously to the journey of all light whilst the second applies only to light observed to have travelled through the opposite demisphere.

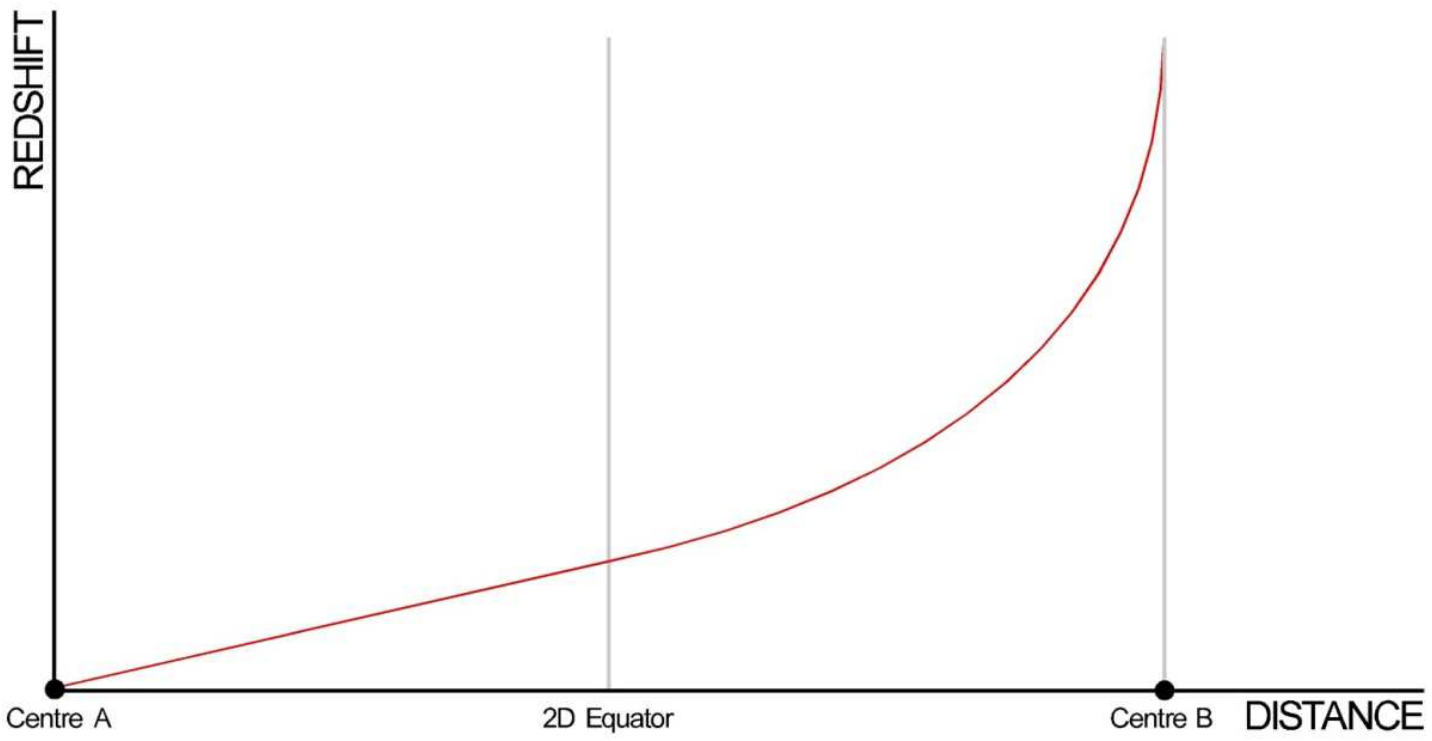

Fig.10 This curve shows the anticipated effect of distance on redshift. Redshift increases linearly between the observer at *Centre B* and the 2D equator, corresponding to the expansion of the universe due to *Centre A/B* recession at *c*. It then begins to curve due to the additional effect of 2D equatorial lensing within the northern demisphere. This observer-centric effect increases exponentially as the line approaches the origin at *Centre A*, appearing to 'emerge' from the singularity which is spread uniformly across the extreme spherical surface by the 'Antarctica effect' of 2D equatorial lensing.

Although questions have always hung over the precise causes of redshift, most distant redshift is now considered to be produced by expansion; however, if a form of 'compound redshift' is generated by the combination of expansion and dimensional lensing this may have repercussions for current measurements of cosmic distance and age for the universe.

[a] See Essay 7

Factor 3) The Information Lag (from Essay 14)

Referred to as *Centre B/B propagation*, there exists a 'lag' in the propagation of information between objects which increases over distance[a]. This delay is due to the fact that, although the current *Centre A/B* state of any point-mass communicates evenly along the separation of *Centre A* and *Centre B* as they recede at *c* (between the edge of the observable universe and the observer), all *Centre B/Centre B* relationships must *then* propagate at the constant *c*. This means that:

- There must always exist a distance-dependent delay between the actual (current) disposition of a point-mass as described by its *Centre A/B* recession, and information relating to its experience of the *Centre A/B* recession of any other point-mass.

From the viewpoint of each point-mass at *Centre B*, the universe distributes this information as sections of its *Centre A/B* recession[b], radially in 3-Dimensions at *c*, obeying Newton's inverse square law with respect to each *Centre B*. The closer together two point-masses are, the shorter the delay as *Centre B/B* information passes between them, therefore the closer to 'identical' their *Centre A/B* relationships.

The diminishing universe

Taking as an example the Sun and the Earth with each as a collection of point-masses: because the information embodied within light and gravitation takes around 8 minutes[c] to travel between them, at any given moment each point-mass *e* within the Earth experiences each point-mass *s* within the Sun (and vice versa) as possessing a *Centre A/B* relationship which is '8 minutes less receded' than it actually is. This means that the universe around each point-mass is increasingly 'out of date' with distance, relativistically at the invariant *c*.

In this way, *Centre B/B* relationships represent the entire state of the universe at every distance, spherically in 'onion skin' shells around every point-mass. The information arriving at *e* tells of a universe whose maximum expansion to date is at *e* (its own *Centre B* experience), whilst the surrounding universe is experienced as less and less expanded over distance. Point-mass *e* therefore experiences point-mass *s* (and vice versa) as inhabiting a universe whose *Centre A/B* radius is 8 light minutes shorter.

Since the only limit to this effect is *Centre A* itself, the diminishing universe must 'act over infinite distance'[d] between all point-masses.

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[a] Varying inversely with the square of the distance between point-masses.

[b] In keeping with the earlier [Essay 9] *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.

[c] Average of 8mins 20sec.

[d] Gravity is said to act over infinite distance. However, within the observer-centric model gravity, as a form of information transfer, acts over the *maximum* but *finite* distance between *Centre A* and *Centre B*.

Fig.11 This (greatly exaggerated) shows the way the universe appears for any two celestial objects of equal mass (bearing in mind that it is not the object *itself* which appears smaller, but the 'shell' of universe it occupies). Both objects comprise a close grouping of point-masses, each of which maintains its own *Centre A/B* relationship. Because of the close proximity of each object's point-mass grouping in comparison to the distance between Object 1 and Object 2, the *Centre B/B* information lag scales up to operate universe-wide at the level of objects as an emergent phenomenon. The *Centre B/B* line between all point-mass pairs behaves (for each) as a section of the line between *Centre B* and *Centre A*, in keeping with our earlier *Pac-Man Principle*[a].

Because of this, another point-mass *a* located at or close to the first point-mass *e*'s antipode at *Centre A* must seem (to *e*) to inhabit a universe which has *not expanded at all*, as all massive objects now in that location are the age of the universe away with an information lag of some 13.8 billion years. All information about *a* now arriving at *e* is therefore 13.8 billion years[b] out-of-date. Because of this, point-mass *e* within the Earth experiences information from its antipodal universe of *Centre B's* as a tiny disappearing singularity which 'dives into' *Centre A*, corresponding to the compression of energy known as the Big Bang.

Information from objects currently[c] located at the antipode will arrive at *e* in 13.8 billion years' time, when point-mass *e* will experience that region as being as expanded as the universe *e* experiences now. Of course, point-mass *a* will no longer occupy the antipodal region, as *Centre A* will then be located at a look-back distance of 27.6 BLY (2 x 13.8) and *e* will then occupy a centre of a universe that has expanded to reflect the recession of *Centre A* from *Centre B* over a look-back time of 27.6 billion years. The observable universe will have doubled its radius, causing information from (what is now) our current antipodal region to appear to have travelled from the 2D equator. Thus, all information that arrives at the observer from the look-back distance of the 2D equator shows the universe as it looked at $L/2$ years ago, where L represents the

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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] By current measurements.

[c] Allowing for relativistic effects on simultaneity.

observer's currently experienced lifetime of the universe[a]. In this way the 2D equatorial surface represents the universe's half-life, explaining why the universe appears to the observer to have emerged from a vanishing singularity.

However, *Centre A/B* relationships are mostly concentrated within massive bodies which are themselves the product of the universe's ongoing effort to 'iron out' the information lag and bring all *B/B* relationships into line with currently experienced *A/B* states. The inhomogeneous pattern formed by the jostling distribution of this information throughout the cosmos in turn defines the contours of spacetime curvature. This shows why gravity may never be shielded against, because the gravitational field is a '3D map' of *Centre A/B* point-mass states as each experiences all the others, and as such merely a description of information throughout the relativistic point-mass 'matrix'.

The information lag cannot apply to the massless particle for the reason that it and the propagation of its information always occupy the same location. The photon's riding of *Centre A/B* recession must coincide with its riding of *Centre B/B* propagation so that no delay can exist between any two photons, anywhere in the universe. This is in keeping with the relativistic nature of the interaction. In the instant that it is experienced by an observer, the photon and its observer occupy the same location with respect to *Centre A*. To the point-mass there is no difference at that moment between its and the photon's experience of 'how expanded' the universe is, therefore, no lag.

Centre B/B information propagates through space at *c* for the reason that space itself is the expression of that information transfer process; i.e. of the outworking of all *Centre A/B* (described by SR), and therefore *Centre B/B* (described by GR), relationships throughout the universe.

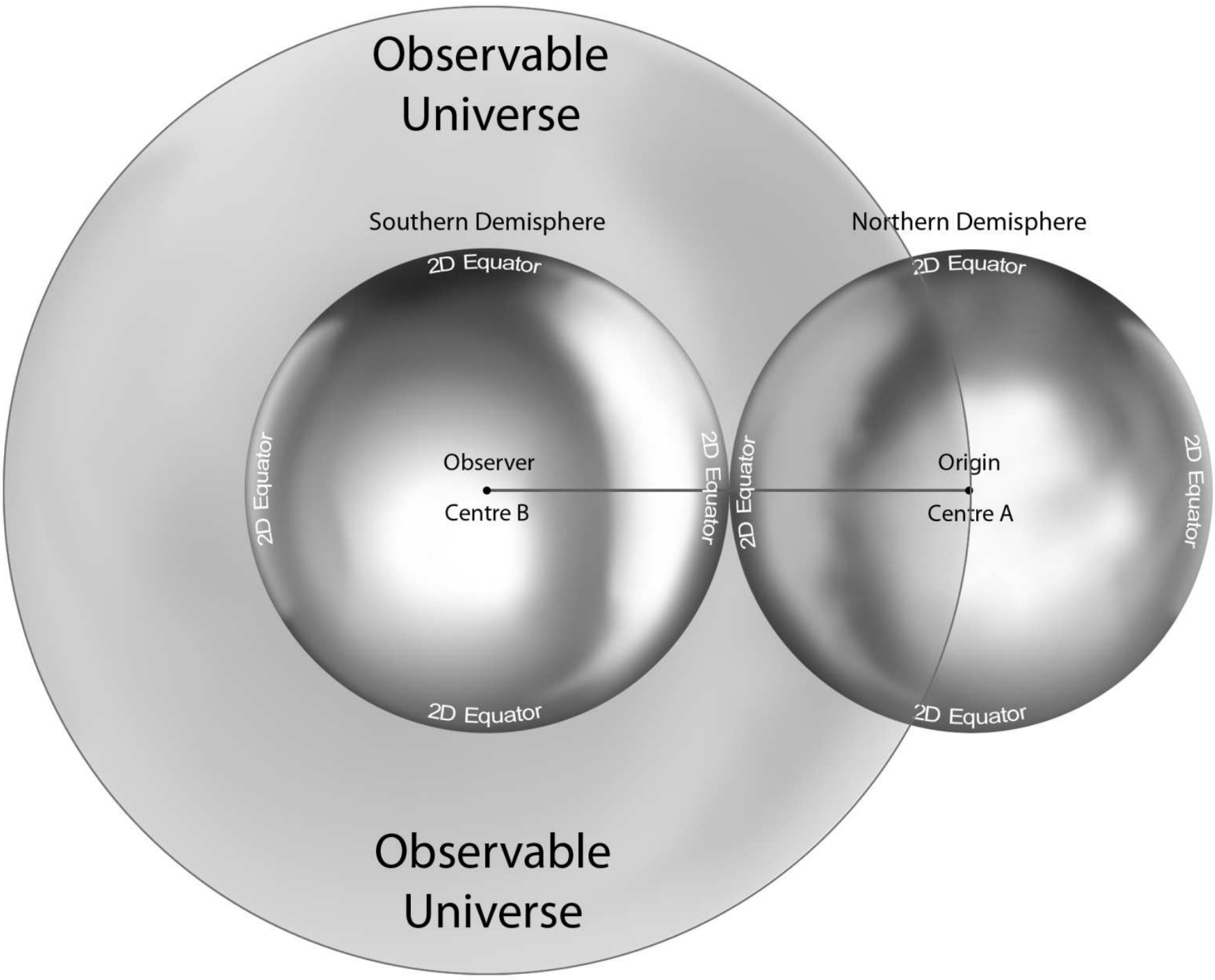
[a] I.e. the age of the universe.

Appendix 3

Synopsis of the observer-centric model of the observable universe[a]

William JE Brown, Aberchirder, Scotland, 25th July 2017

Abstract: This finite model of the observable universe is the 3-sphere of Einstein, with the crucial difference that observer and origin are located at antipodal centres (poles) of the 3-hemispheres, rendering the whole 'observer-centric'. Without altering constants, GR, or QM, the model solves the horizon problem of CMB uniformity, explains the 1998 distant SNe Ia light anomaly, shows the universe to have net zero gravity (explaining so-called dark energy), reveals the correct mechanism behind expansion, shows in terms of information transfer why both gravity and light exist at *c*, describes the mechanism by which the universe diminishes to a Big Bang singularity, and provides a theoretical basis for the Equivalence principle. In the process it dispenses with infinity, superluminality, Cosmic Inflation, the G/DE knife-edge, recent acceleration, and the cosmological constant.



The observer-centric model of the universe[a]: With the demisphere surfaces in full contact at every corresponding point, the lines that radiate away from and into each demisphere connect *Centres A* and *B*. The outer circle represents the distance of *Centre A* from *Centre B*, as viewed by the observer beyond the 2D equator spherically in every direction by the 'Antarctica effect'.

[a] Abridged from the author's book, *A Dimensional Structure for Reality*, https://www.amazon.co.uk/dp/197390795X

Background: In March 2012 the question was asked... what if the 3+1 dimensions of our world are not what dimensions actually are, but are instead merely representations of an underlying structure of which they exhibit properties? A set of geometrical principles was then extracted from EA Abbott's *Flatland* [*Appendix 1*] and 'tried out' on reality to see whether they fit. A fundamental but consistent dimensional structure emerged in the form of an observer-centric nested hierarchy. Within this structure, at the level of the 3rd and 4th Dimensions:

- Principles derived from EA Abbott's *Flatland* were applied to the observable universe in order to examine the possibility that the universe we observe in the present might behave, not as a small 'snooker ball-style' part of an infinitely greater whole, but as a cross-section within an inductive dimensional hierarchy.
- Extrapolation of the Flatlanders' perception through 1/2/3/4D generated the phenomenon of 'observer-centricity', applying at each spacetime-event.
- Since a 3D slice of a 4D hypersphere is a sphere, the observable universe 'bubble' was investigated to see whether it might indeed behave as a cross-section.
- This led, via the 'globe analogy' and the 'rolling balls' experiment, to the comparison of a theoretical path of light – from origin at *Centre A* to observer at *Centre B* through northern and southern '3-hemispherical' halves (demispheres) of the hypersphere – with various observed phenomena such as the Big Bang, the CMB, the CIB, the positions of galaxies, the speed of light, gravity, SR, GR, redshift, expansion, Type Ia supernovae, dark energy, recent acceleration etc.
- With particular emphasis on the significance of the 2D equatorial surface which unites the twin demispheres, the observer-centric model furnishes explanations in terms of the 'Antarctica effect', 2D equatorial lensing, the half-circumference path of light, net zero gravity, *Centre A/B* recession and the *Centre B/B* information lag.

Description:

Sphericality:

- Extrapolating up from the Flatlander's 1D (edge-on) view of his 2D spacetime we experience the 4D hyperspherical 'block universe' as a single 3D spherical cross-section which is centred on each observer (i.e. each spacetime event).
- This is the finite universe which wraps around Pac-man-style.
- This 3-sphere (the observable universe) consists in two spherical demispheres as per Einstein's description [Relativity Ch31], touching at every point on their 2D equator, but...
- The observer looks out from the centre of one of these (*Centre B*) with the origin at the (antipodal) centre of the other (*Centre A*). This is key.

Longitude in 3D:

- Straight lines join *Centre A* and *Centre B* in all 3D directions [Relativity Ch31].
- The Big Bang origin, although a 'point' at *Centre A*, is thus viewed from each *Centre B* projected spherically across the surface of the observable universe at maximum distance, (like the Mercator projection of Antarctica on the Earth's 2D surface).

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[a] The twin spheres are northern and southern 3-hemispheres, or hemi-balls, which divide the surface of the 4-Dimensional universe in half. To distinguish them from our accustomed Earth-style hemispheres I will use the historically redundant term, 'demispheres'.

- Relic radiation crosses the 2D equator and converges spherically on each observer (like lines of longitude on the Earth's poles but up by one dimension), with its single 'opposite polar' source at each observer's antipode on the 3D surface of the hypersphere, explaining the CMB's uniformity.
- This dimensional lensing (the 'Antarctica effect') is observer-centric because every location in space through time is a *Centre B*, polar opposite to an antipodal singularity at *Centre A*.
- All taken together, as a 'stack' of spheres each centred on an observer, these 'observable universe' spheres comprise the 4D (hyperspherical, block) universe in the same simple *Flatland* sense that a plane is composed of 'stacked and fused' lines.

Dimensional Lensing:

- 2D equatorial lensing explains the SNe Ia light anomaly discovered by the two US teams[a] in 1998 because it renders all distant objects dimmer than they ought to be for their distance as they project over a slightly wider area on the 2D equator before converging on the observer at *Centre B*.
- 2D equatorial lensing causes the observer to experience increasingly diffuse galaxies, the CIB, and the CMB as the *same graduated phenomenon* over increasing distance.
- Because 2D equatorial lensing stretches light as a secondary cause (in addition to expansion) of redshift, it may be that cosmic distance and age require to be revised.

Expansion:

- *Centre A* and *Centre B* recede from one another at *c*, in keeping with SR.
- This recession is relativistic so that light's 'whizzing past' results in perception by observers with mass (who experience *Centre A/B* recession at *c* mainly as time) of an expanding universe.
- Light may only ever travel a retrospective half-circumference of the universe because every spacetime-event constitutes a *Centre B*.

The Information Lag:

- *Centre B/B* propagation at *c* of information relating to *Centre A/B* recession at each point-mass results in a *Centre B/B* 'information lag' throughout the universe.
- This renders the universe itself 'less expanded' over distance <u>with respect to each observer</u>. (E.g. the shell occupied by the sun is 8 min less expanded because information received re *Centre A/B* recession at the sun is 8 mins out of date.)
- With respect to each *Centre B*, the information lag results in a universe that diminishes over distance to a singularity at *Centre A*.
- The information lag *is* gravity, as all point-masses at *Centre B* seek to iron out the information lag by occupying the same location.
- Attraction between large bodies emerges from this.
- Successful ironing out of the information lag must result within a black hole singularity.
- The massless particle, although occupying a *Centre B* and subject to Relativity, experiences no information lag as it exists at the same speed as information transfer, 'riding' expansion.

[a] The High-Z Supernova Search Team led by Adam Riess of the Space Telescope Science Institute and Brian Schmidt of Mount Stromlo Observatory, and the Supernova Cosmology Project led by Saul Perlmutter of Lawrence Berkeley National Laboratory.

Net Zero Gravitation:

- The twin demispheres exist in 'seesaw-like' equilibrium in a universe-wide state of net zero gravity.
- The observer's opposite demisphere exerts a pull spherically away from the observer in all directions which increases over distance, resulting in 'repulsive gravity'/'dark energy' which obeys GR.
- This pull is zero at each *Centre B*, being spherically equivalent, so that the gravitational influence ('negative pressure') of our opposite demisphere appears absent from our (i.e. the observer's) locale.
- All angles/parallel lines are normal in 3D (i.e. appear Euclidean) within the observer's own southern demisphere (except as affected locally by the information lag).
- 'Bending' into the 4th Dimension takes place at crossing of the observer's 2D equator; each line continues on its own straight path whilst all angles of incidence change.
- The gravitational field is a 3D 'matrix' of *Centre A/B* point-mass states as each experiences all the others.

Equivalence: Science writer Jim Baggott writes, *'Inertial and gravitational mass are empirically identical, although there is no compelling theoretical reason why this should be so.'* However, by defining them in terms of *Centre A/B* and *B/B* relations we may discern a common process at work:

- ***Inertial mass:*** When a force is applied to a massive object, this constitutes an attempt to alter all its *Centre B/B* relationships with the rest of the universe, which it resists in proportion to the total amount of *Centre A/B* relationship information that would require to be changed as measured by its 'number of point-masses', or mass.
- ***Gravitational mass:*** When an object experiences the influence of a gravitational field, it is subject to an attempt by a very large grouping of point-masses to draw *each and every* point-mass into the same location, ironing out the information lag so that the *Centre A/B* experience of each corresponds *exactly* to the *Centre B/B* experience of each. As with inertial mass, this must involve a change in the total amount of *Centre A/B* relationship information within the object which is proportional to its 'number of point-masses', or mass.

From this, the underlying theoretical reason for these to be empirically identical is that both inertial and gravitational mass demand a change in the total amount of *Centre A/B* relationship information that must be communicated between every *Centre B* within the object and every *Centre B* throughout the rest of the universe, at *c*. The object offers up resistance (inertial) or compliance (gravitational) to this change, in proportion to its 'number of point-masses', i.e. the object's mass.

Conclusion: The model represents a unified and consistent cosmological picture of a finite 'Pac-Man' universe which is equivalent to Einstein's hypothetical (some say preferred, *'since all points on it are equivalent'*) description of a spherical universe, but with the addition of origin at *Centre A* and observer at *Centre B*. The observer-centric model was not originally derived from the Standard Model or Einstein's finite 3-sphere, but by the application of consistent dimensional logic to the cosmos by extrapolation of *Flatland* principles, starting from the way the Flatlander would experience a theoretical 2D spacetime. As such it is not a stand-alone hypothesis but part of a greater dimensional structure based on consistent geometrical principles extracted from EA Abbott's *Flatland*. Its formidable explanatory power – and its major difference from other models – is that it is counterintuitively observer-centric, with origin and observer (i.e. any spacetime event) located at the antipodes: *Centre A* and *Centre B*.

Appendix 4

Index of Concepts

Essay 1: The spatial/temporal distinction

Why the world is 3D.
Time is not intrinsic to the 4th Dimension.
The 3D/4D shape of the observable and global universe.
A *Flatland*-based dimensional structure is observer-centric.
Derivation of the model from *Flatland* principles.

Essay 2: The magic treadmill of time

The temporal dimension emanates from the observer's location.
Why the temporal dimension is invisible.
Time obeys the same dimensional principles as space.

Essay 3: Observer-centricity

Each spacetime-event constitutes an observer location.
The universe is observer-centric.
The observer views from its centre one unique, spherical, 3D cross-section of the 4D block universe.
All observers view the same origin event at different aspects.

Essay 4: CMB uniformity

The observer is located at an antipodal point on the 3-sphere surface to the (Big Bang singularity) origin of the observer's location.
The omni-directionality and smooth homogeneity of the CMB are explained using the globe analogy, rendering Inflationary explanations redundant.

Essay 5: The observer-centric model

The 'observer-centric model' of the observable universe.
Action of the 2D equator described using the 'rolling balls'.

The observer at *Centre B* views the origin at *Centre A* omni-directionally on the extreme surface by the 'Antarctica effect'.

The finite volume of the observer-centric universe is not 'real' in the straightforward objective sense with which we are familiar, but as a 3D spherical cross-section of the 4D 'hypersphere' or 4-ball, as viewed from a centre by an observer[a] in accordance with the *Flatland*-derived *'Edge-On' Principle*[b].

Essay 6: Einstein and sphericality

Einstein confirms the integrity of dimensional analogy and extrapolation as a means of investigating the universe.

Sphericality is preferred because *'...of all closed surfaces, the sphere is unique in possessing the property that all points on it are equivalent.'* [c]

Einstein presents physicists of the future with only two options for the universe's shape: *'infinite'*, or *'finite in the manner of the spherical universe'*. [d]

The observer-centric model is the spherical universe of Einstein, with the addition of origin and observer at antipodes (designated *Centre A* and *Centre B*) on the 3-sphere surface of the 4-ball.

Essay 7: The half-circumference of light

Circumnavigation of light is not possible.

Relic radiation has always travelled a retrospective half-circumference of the universe with respect to the observer.

Centre A and *Centre B* recede from one another at *c* (termed *Centre A/B* recession), in keeping with Special Relativity.

The photon, although massless, is also an observer occupying its own *Centre B* in keeping with SR.

Observer-centricity corresponds to strong complementarity.

The 4-ball (or block universe) comprises the sum total of all 3D viewpoints through all of time, 'fused' in keeping with the Flatland-derived *Principle of Character*[e].

Essay 8: Expansion

To the observer with mass, the increase in 3D information required to define the universe manifests as expansion.

Expansion results from ongoing relativistic 'readjustment' at each *Centre B* due to *Centre A/B* recession

Superluminal recession produced by a faster-than-light expansion of 'space itself' does not apply. (Apparent superluminal recession of distant galaxies is accounted for by 2D equatorial lensing, see Essay 13.)

Since the universe is not collapsing under gravity or being resisted by 'dark energy' current explanations of expansion are redundant (see Essay 12).

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[a] See Essay 1

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

[c] Albert Einstein, *Relativity* (1916), Routledge 2001

[d] Ibid.

[e] *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.

Essay 9: Distant objects (single observer), and Essay 10: Distant objects (two observers)

Describing the path of light through the finite observer-centric universe using the 'rolling balls'[a].
As measured by a single observer, all paths (including parallel lines) and angles will behave according to Euclidean geometry within the observer's own demisphere.
'Bending' into the 4th Dimension takes place at the observer's equatorial surface.
Euclidean flatness will appear to be a global phenomenon throughout the universe if the action of the rolling balls is not taken into account.

Essay 11: The ghost universe

Back-light throughout the universe results in an inverted but undetectable 'ghost universe' which surrounds each observer.

Essay 12: Net zero gravitation

The observer-centric model describes a 3-sphere observable universe in which the gravitational influence of each demisphere upon the other results in a system in equilibrium.
Our concept of dark energy as 'anti-gravity' may describe the gravitational influence of the observer's northern demisphere, which increases spherically with distance from the observer. (The mechanism of expansion[b] does not depend upon gravity/dark energy as an 'energy of the vacuum', as currently understood.)
Being spherically equivalent at *Centre B*, this pull would remain undetectable by the observer – i.e. measured as zero at the observer's location.

Essay 13: 2D equatorial lensing

2D equatorial (dimensional) lensing causes the observer to view the Big Bang origin on the extreme surface of the observable sphere.
2D equatorial lensing renders the increasing diffusion and redshift of distant galaxies, the CIB, and the CMB as the same graduated phenomenon over distance.
2D equatorial lensing explains the distant Type Ia supernovae light anomaly discovered in 1998, rendering superfluous recent acceleration and the (re)introduction of the cosmological constant.
Apparent superluminal recession of distant galaxies is accounted for by 2D equatorial lensing.
Apparent inhomogeneity is accounted for by 2D equatorial lensing.
As 2D equatorial lensing produces redshift, cosmic distance and age may require to be revised.

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[a] See Essay 5
[b] See Essay 8

Essay 14: The Information Lag

An information lag exists throughout the universe as the *Centre B/B* propagation at *c* of information relating to the *Centre A/B* recession of each point-mass.
This results in a universe which diminishes in size over distance with respect to the observer, in keeping with the inverse square law.
As the diminishing universe approaches zero at the antipode, this takes the form of space and time 'diving into' the Big Bang singularity at *Centre A*.
The information lag accounts for gravity as the tendency of all point masses to iron out the lag by occupying the same location.
The massless particle does not experience the information lag because, existing at *c*, it 'travels' at the same speed as information, riding *Centre A/B* recession / *Centre B/B* propagation.
Centre A/B recession is described by SR; *Centre B/B* propagation is described by GR.
The information lag provides an underlying theoretical basis for the equivalence of inertial and gravitational mass.

Essay 15: Quantum Gravity

Incompatibility of the discrete (Quantum theory) with the smooth (General Relativity) may be overcome within a more fundamental *Flatland*-style dimensional structure.

Appendix 5

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Appendix 6

Further Information

This series of essays relating to physics and cosmology is an abridgement of Sections 2, 5, and 6 of the author's book, *A Dimensional Structure for Reality*. Aimed at the specialist, although not adhering strictly to the style of the scientific paper they are written with similar economy, assuming prior knowledge of EA Abbott's *Flatland* (1884). Ideas from Section 1 of the book (introduction to Flatland and the 4th Dimension), Section 3 (dimensional structure), Section 4 (gravitation), and the final two Sections 7 and 8 (relating the structure to life and consciousness) are not covered.

Although the dimensional structure is consistent and never deviates from *Flatland* principles, as it builds it must necessarily become vastly more complex. This complexity renders it less accessible to maths/physics as it enters the realms of biology, psychology and philosophy. However, because the structure is geometric, extrapolation of *Flatland*-derived principles generates a fundamentally logical framework which embraces perception, creativity, memory, reproduction – and even, in principle, spirituality – affording analogical insight into the differing conscious experience of all living things. The place of life and consciousness within the structure is discussed in Sections 7 and 8 of the book, beginning with five reasoned evidences for a *Flatland*-based dimensional structure of life:

1) The 'central viewpoint triad'
2) The 'dimensional axis'
3) The 'humansphere'
4) The 'lifetime of the universe'
5) Newton's 'great animall'

The structure builds as a *Flatland*-style nested hierarchy into 5th, 6th and 7th Dimensions (and potentially higher), so that life itself is the expression of the same consistent structure. I have not included these ideas within the *15 Essays* as they are predicated on the lower dimensional structure being correct – for which we await confirmation! However, key chapters from these sections may be accessed through the website at *dimensionalstructure.com*

15 essays online:
www.vixra.org/abs/1803.0194

Website:
www.dimensionalstructure.com

Abridged from:
A Dimensional Structure for Reality, William JE Brown
www.amazon.co.uk/dp/197390795X

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