Chapter 31

Light from Distant Galaxies

Whichever direction you look in the sky, the line that stretches from you at *Centre B* to your origin at *Centre A* cuts a cross-section through the history of travelling light. This is fine when viewing nearer objects which are located within your own (southern) demisphere, but, because this line crosses the 2D equator at its mid-point, all celestial objects beyond this distance are viewed as located within your opposite (northern) demisphere. However, unlike the CMB, distant galaxies are not projected Antarctica-style all over the sky. The reason for this is that the CMB was an everywhere-event close to the beginning of time, whereas galaxies are localised and we see them much as they were when the light left them[a].

Having described the path of light from the ubiquitous CMB, let's now consider what happens to light radiated from individual objects throughout the universe such as galaxies, supernovae, quasars etc, starting with the question, *'What happens to light from a galaxy located within my own southern demisphere, on this side of the 2D equator?'*

The answer is of course, nothing strange. Apart from for the local space-time curvature of any gravitational fields it might encounter en route and the phenomenon we experience as the stretching of space, the light comes at you on a straight path and the galaxy is viewed exactly where it is. However… *'What happens to light from a galaxy located in my northern demisphere, just beyond the 2D equator?'*

A Whole New Ball Game

This is somewhat more complex due to the fact that, as the 3D expression of a single compact system in 4D, the twin demispheres share the same surface. The observer views the universe in 3-Dimensional cross-section from *Centre B*, with *Centre A* viewed omni-directionally on the surface of the observable sphere at maximum distance in space[b]. This has the effect of altering the relative positions of celestial objects in the northern demisphere in ways that are – although consistent with existing ideas of the Pac-Man universe – not intuitively apparent.

> *Reflection…* All this is not nearly as complicated as it sounds. It takes a little while, but once the penny drops and you begin to get used to 'rolling the balls' in your mind, the sky will never look the same again! Remember, this is not a description of how the universe objectively *is* – as though there were two giant physical balls out there like the world that we all live in different parts of – but instead how *any observer* located *anywhere in the universe* experiences the universe. In other words, an observer located in a distant galaxy would see the same twin demispherical view from her own *Centre B* experience.

[a] Although projection must produce a highly significant '2D equatorial lensing' effect which increases with distance into the northern demisphere, which we will look at shortly.

[b] The combined radii of the northern and southern demispheres.

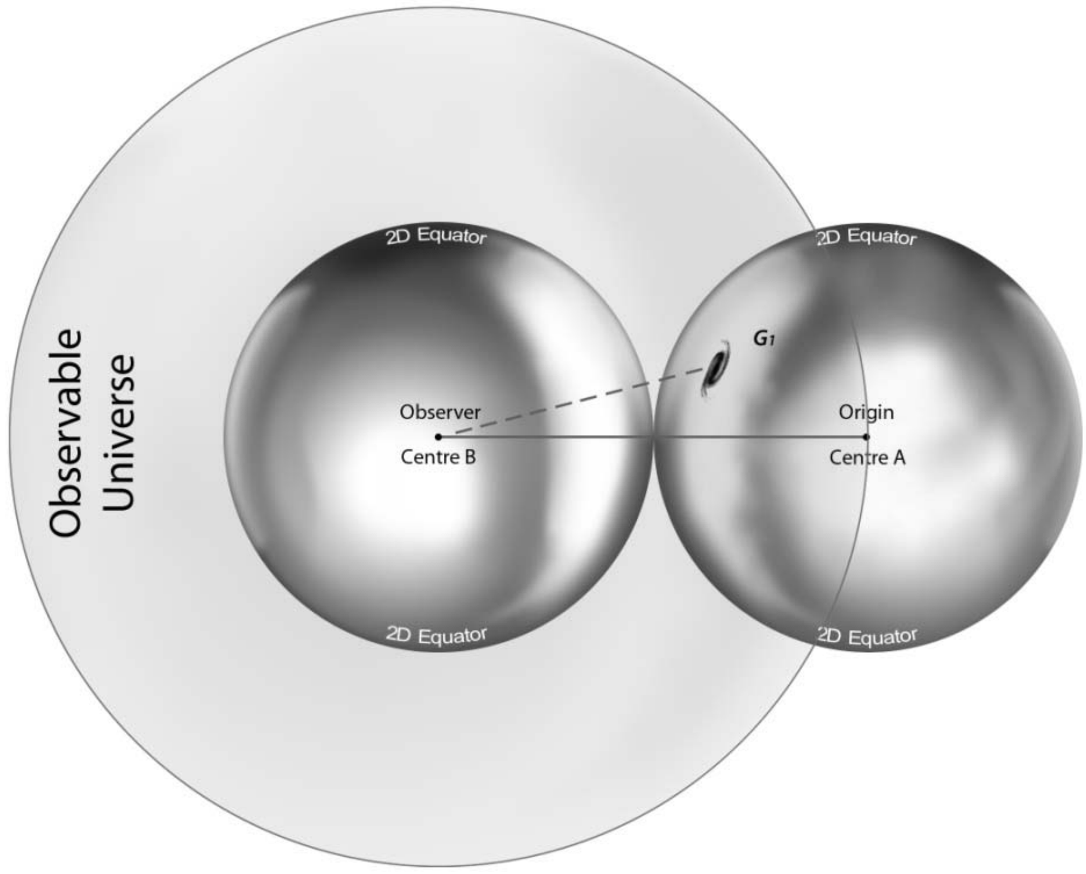

Fig.1 This is the position of galaxy G_1 relative to the origin at *Centre A*. At first glance, G_1 looks on the diagram[a] to be off to the left of my field of vision (dotted line) as I look out from *Centre B* toward *Centre A*. However, in the twin demisphere model this does not represent the galaxy's true position in the sky (i.e. where the observer actually sees it).

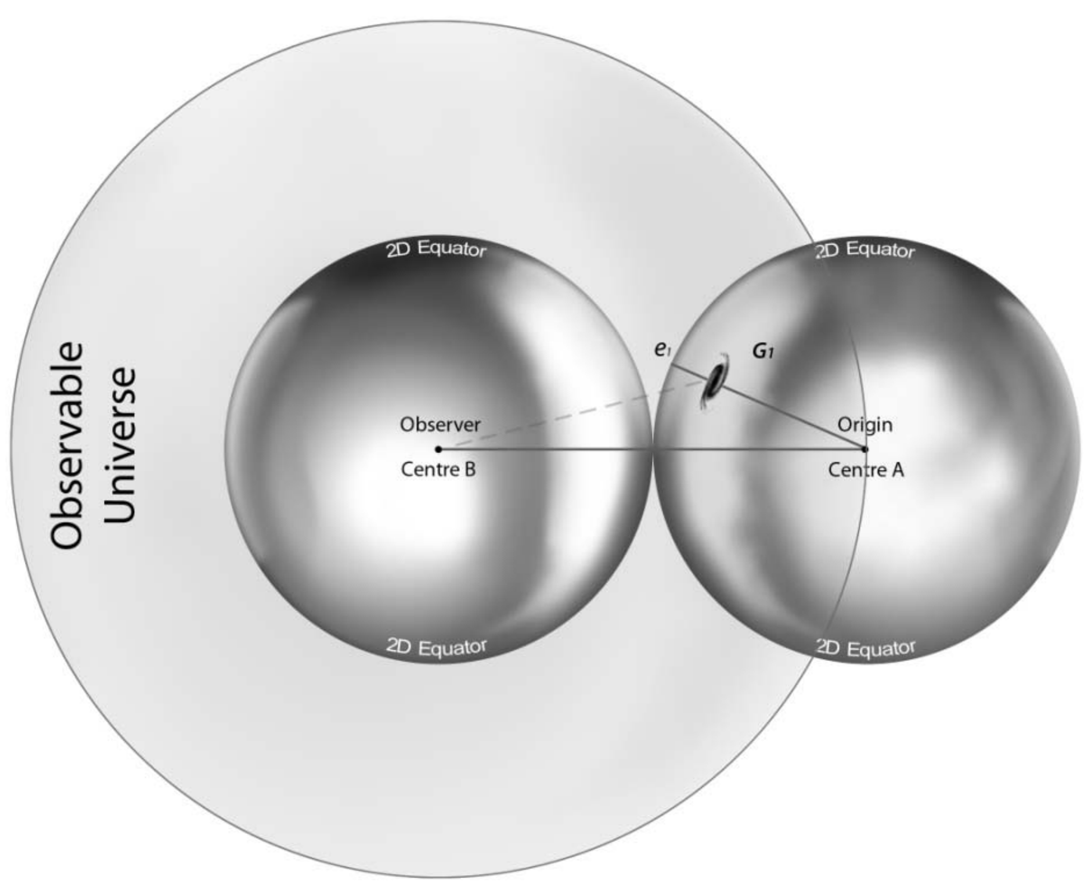

Fig.2 To find this we draw a line from the origin at *Centre A*, through the galaxy G_1 and continuing as a radius to a point e_1 on the 2D equator at the perimeter of the northern demisphere.

[a] The diagrams are necessarily flat, but remember that the balls roll in 3D.

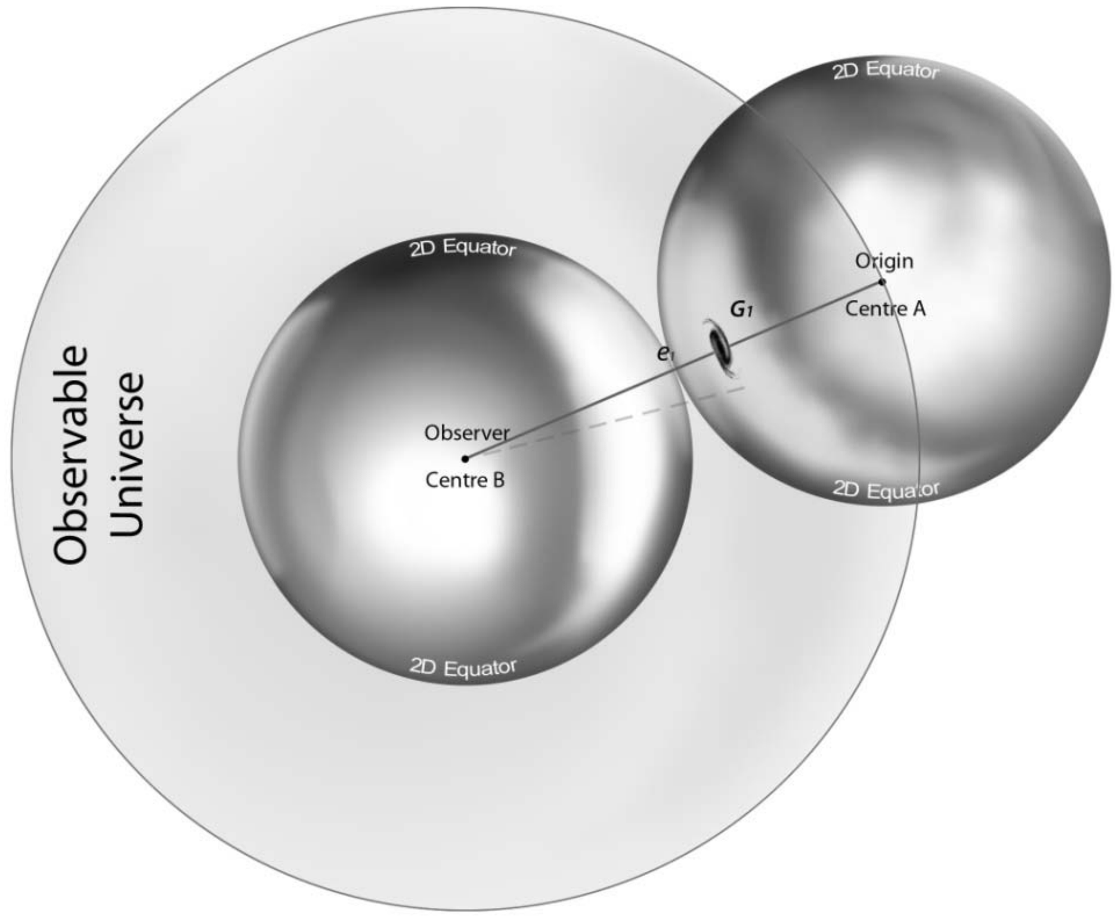

Fig.3 We then 'roll the balls' until equatorial point e_1 meets its corresponding equatorial point[a] on the perimeter of the southern demisphere, and continue the line as a radius to the observer at *Centre B*. This is now the correct direction in which I view the galaxy. Note that *the line through the object must always be a straight line joining Centres A and B*.

'But what happens to all the light that radiates from distant galaxy G_1 in other directions?'

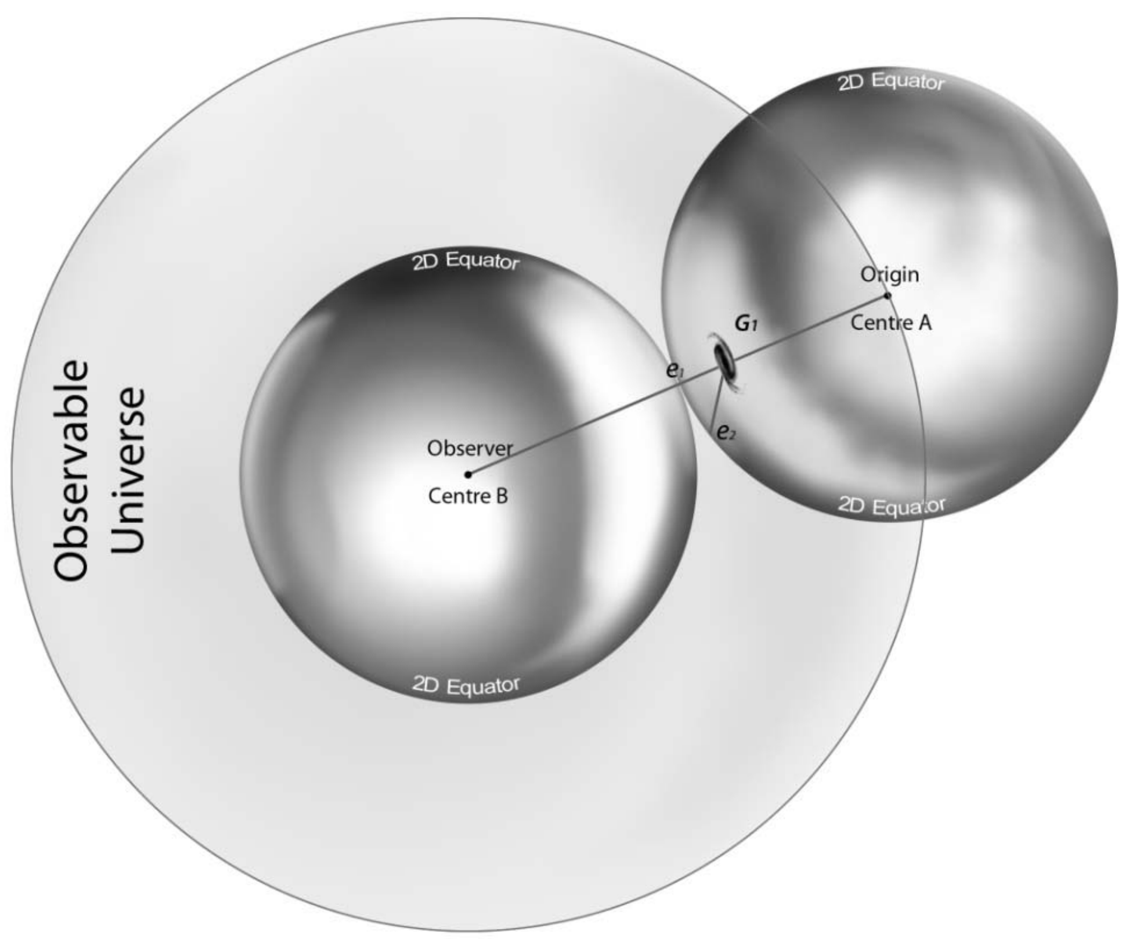

Fig.4 This illustration shows a single beam of light from G_1 which hits the 2D equator at point e_2. Again we roll the balls until the equatorial points meet at e_2.

[a] 'Miami to Miami', as explained in Chapter 27.

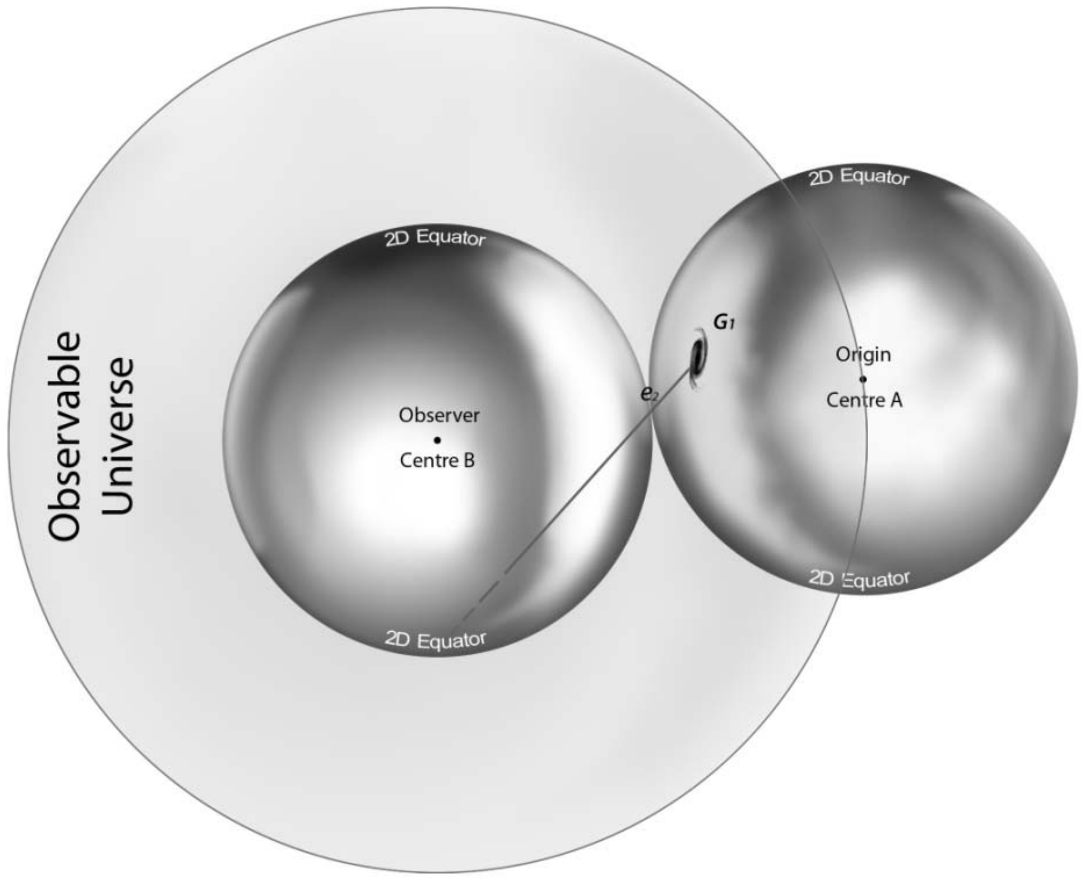

Fig.5 The light crosses the equator in a straight line at an angle relative to the observer. We may do the same for every beam of light which radiates away from the galaxy in every direction, rolling the balls so that each beam crosses the equator at the same angle it arrives. In this way, *the observer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

Remember that these angles are only relevant to *my* position at *Centre B*. This 'other' light from the object will not be viewed by me but is available throughout the universe to be viewed from other *Centre B's* which may be located anywhere. Each observer on the light's path will view the light from their own *Centre B* 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).

That's all very well but… *'What happens to light from a galaxy located beyond Centre A at the far side of my northern demisphere – doesn't it lie outside my observable universe?'*

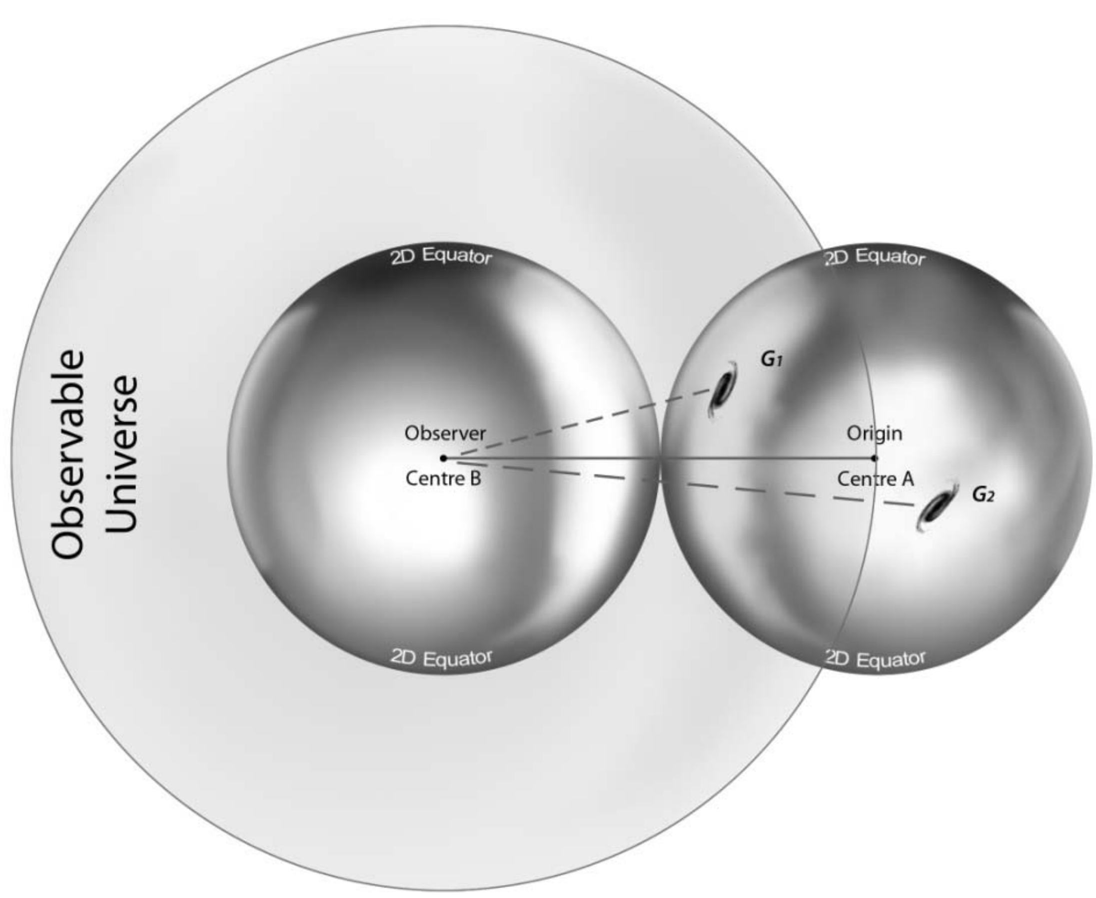

Fig.6 At first glance, it would appear that galaxy G_2 lies beyond the observer's *Centre A* origin – like Λllen from next door's snooker ball in Chapter 27 – and therefore beyond the cosmic horizon of my observable universe.

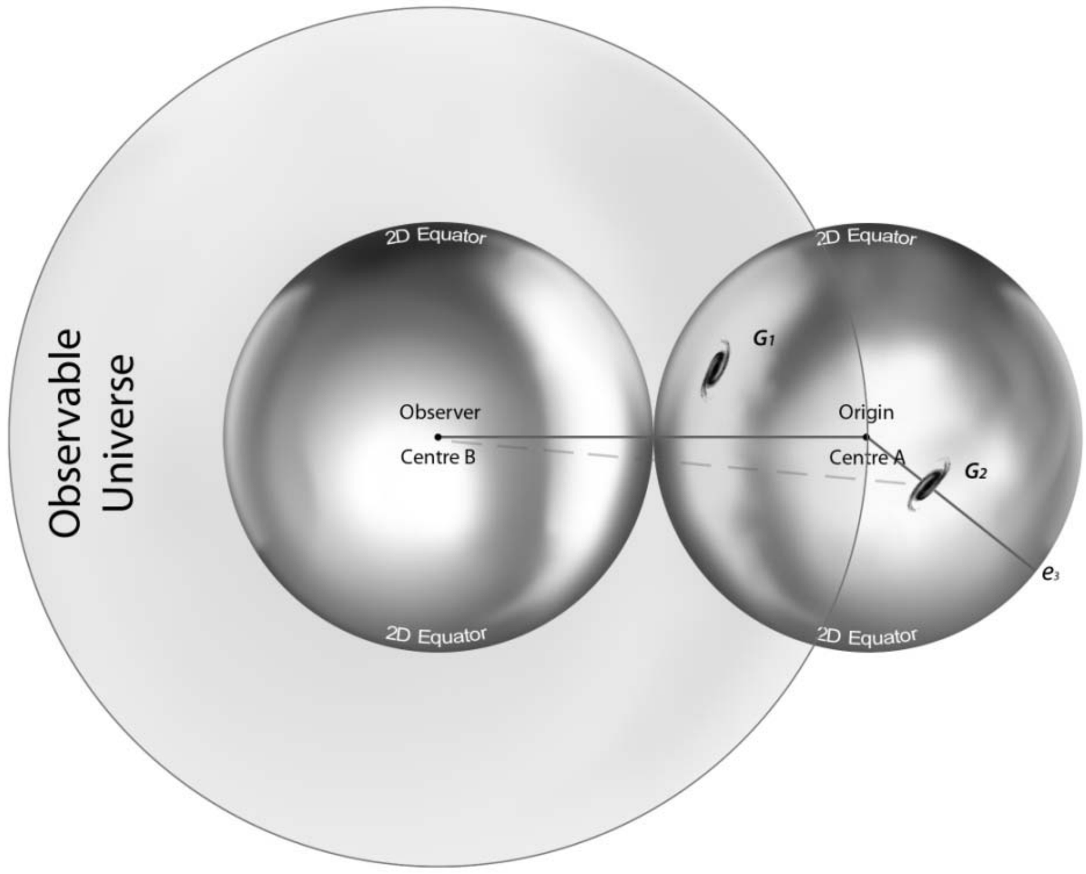

Fig.7 However, this only holds until we perform the same operation as above, drawing a radius from the origin at *Centre A* through the galaxy G_2 to the perimeter of the northern demisphere at the equatorial point e_3.

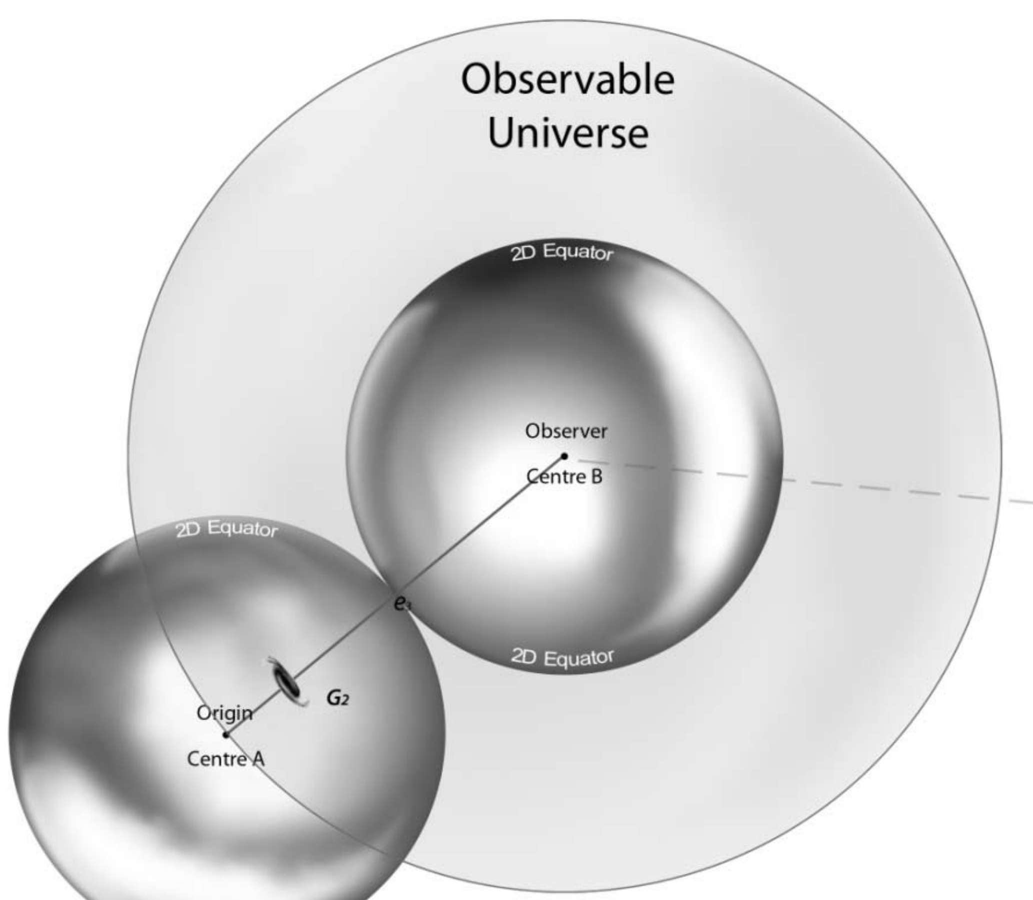

Fig.8 We then roll the northern demisphere right round until the point e_3 meets the equatorial surface of the observer's southern demisphere. The line then continues as a radius to the observer at *Centre B*. This is now the correct direction in which I view the galaxy ('behind' me), and the distance may now be measured and seen to be less than the distance from me to the edge of the observable universe[a]. In this way, everything that the observer views from *Centre B* is closer than *Centre A*.

[a] Which is located, by rolling the balls, at *Centre A* in every 3D direction from *Centre B*.

As stated at the outset, this 'rolling' process is only required to describe the positions of objects which are far enough away to lie in the observer's opposite (northern) demisphere, beyond the 2D equator, because the positions of objects within the observer's own (southern) demisphere are actual, as viewed. However, ***from the observer's viewpoint, the position of a galaxy in either demisphere is viewed in exactly the same way***: radially in 3D at a point on the line that connects the origin at *Centre A* with the observer at *Centre B*. There is a principle at work here which applies to all light in the universe, not just the CMB. Let's call it…

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 simple mathematical principle describes how every observer throughout the universe proper sees *all the same stuff, but from different angles*, and accounts for the isotropy and, by implication, homogeneity of the universe. It's because it is all the same universe, viewed from all different cross-sectional locations (*Centre B's*) within the hypersphere. Consequently, there are no distant galaxies located farther from us than the distance that light has had time to travel. In the twin demisphere model, ***the edge of the observable universe does not form a cosmic horizon beyond which light has not had time to reach us***, because any light we might think of as travelling directly away from us simply enters our own demisphere behind us, which is where we see it, and any object located 'just beyond' the observable horizon will be seen 180° behind me – *from the back!*

In this way, the *Pac-Man Principle* solves at least one major 'horizon problem' of cosmology.

It's important to get our heads round the fact that no physical thing can exist outside the twin demispheres. There is no outside. They share the same surface, therefore to leave the one is to enter the other, and vice versa, as per the seesaw analogy of Chapter 27. The twin demispheres constitute, in a sense, the ultimate prison – a closed system as experienced by any observer at any location from which not even light may escape, and every physical thing that exists must lie between the observer and the origin, in one direction or another in the sky[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* observable universe, and therefore the radius of the universe proper, as measured in cross-section at a moment in time.

In other words, at any given moment, ***the universe as observed by any observer from any viewpoint is the entire universe***. It is, as postulated by Einstein fully a century ago, *'finite in the manner of the spherical universe'*.

From this we may see that – contrary to the current Standard Model – 'space itself' does not expand faster than light, because light may *only ever* travel from *Centre A* of the northern demisphere (the origin) to

[a] Of course, as a bare philosophical statement, *'every physical thing that exists must lie between the observer and the origin'* is clearly true, but the twin demisphere model supplies a geometrical explanation for what is otherwise simply an ethereal concept.

Centre B of the southern demisphere (the observer), which it does at 299,792,458 m/sec. 'Opposite sides of the sky' from the observer are not superluminally distant from one another. They are the same point.

Reflection… Remember, none of this is to say that the observable universe and the universe proper are the same thing, because:

1) ***The observable universe is 3D***. It is the view of all light that arrives at a single viewpoint – *Centre B* – at an instant in time, experienced by the observer as the present. As observed from one *Centre B*, the edge – viewed as the projected spherical surface at *Centre A* – contains within it the travelling light of the entire history of the block universe from creation to the moment now, comprising one 3D cross-sectional slice.
2) ***The universe proper is 4D***. It is the block universe, the sum total of *every* *Centre B* viewpoint through the whole of time: past, present and future. In other words, the coalescence of every discrete space-time event into a smoothly completed 4-Dimensional 'thing' which we may represent as a hypersphere, in accordance with our *Flatland*-derived *Principle of Character*[a].

If you're finding these diagrams heavy going, just skip forward to the next chapter (or even the one after that, Chapter 33, as the next one relates to a few more of these technical issues...)

To those of you keen to persevere I'd like you to…

Meet Λlienna

She lives on a planet 4 billion light years away. I can see her star system and she can see mine, but there is no point in trying to communicate because it would take more than 8 billion years to get an answer! The question that arises is this:

'How does Λlienna view galaxy G_1?'

In order 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* above):

[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.

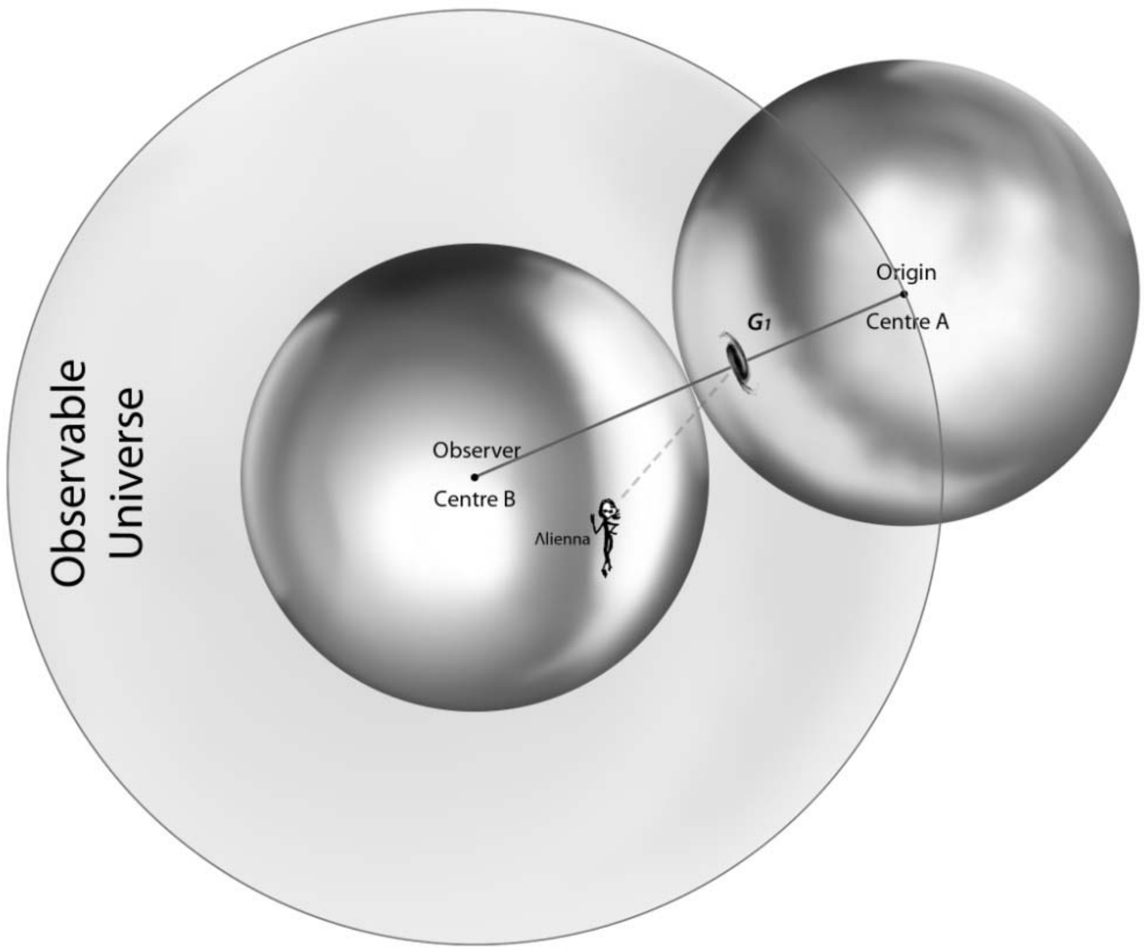

Fig.9 This illustrates the path of light from G_1 to me, and also the path of light from G_1 to Λlienna *as I might imagine it to be* in terms of the twin demispheres as I experience them from my own *Centre B*. However, the purpose of this diagram is to show that this view is in error, because I do not view the universe objectively as it is. And Λlienna does not view G_1 as inside my opposite demisphere, because *observer-centricity places her at the centre of her own universe experience*.

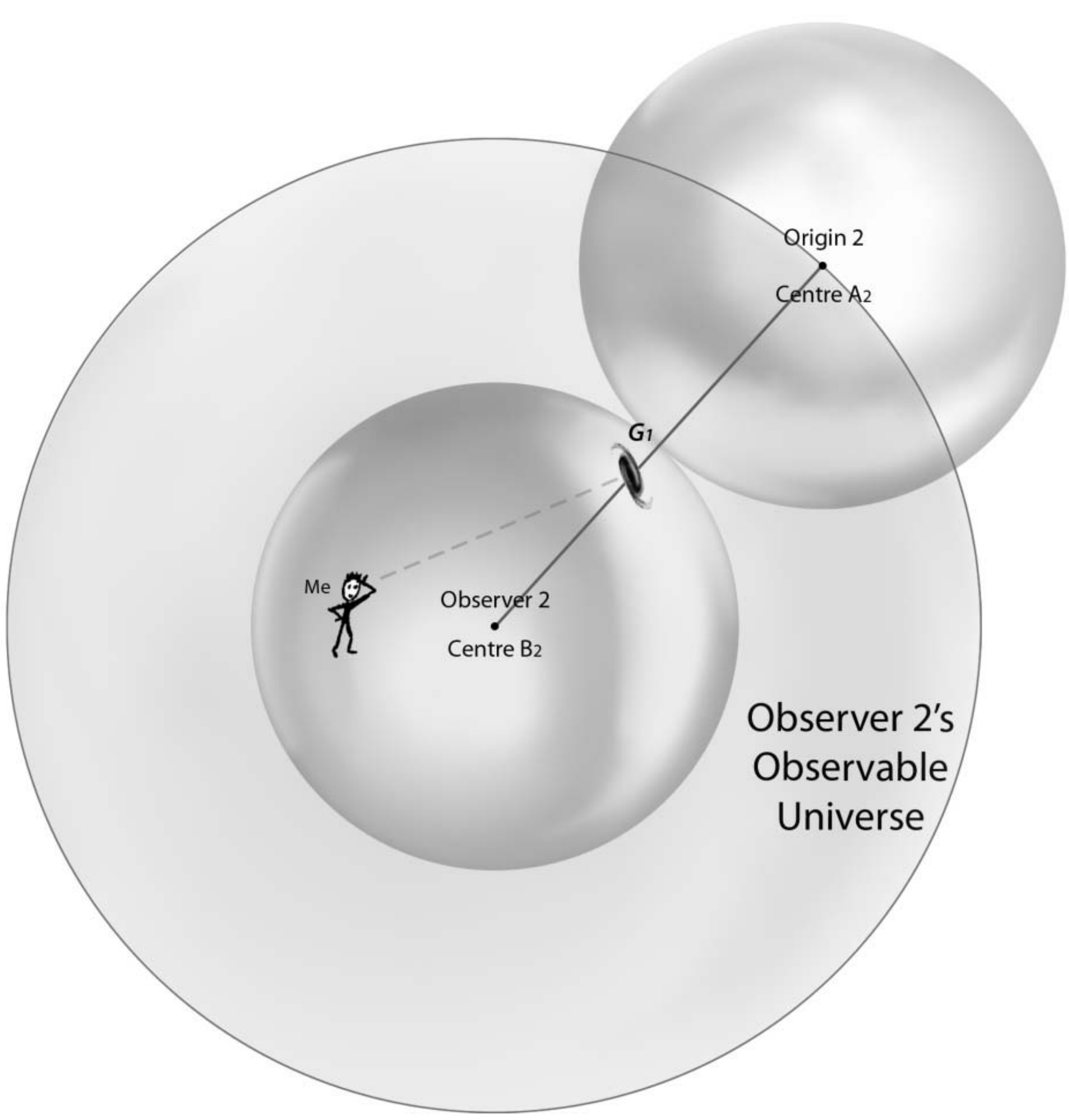

Fig.10 Placing Λlienna at the centre of her own twin demisphere experience – which we will designate *Centre* B_2 – this shows Λlienna's view of the universe. Galaxy G_1 is viewed by her as located *within her own (southern) demisphere*, because the distance between them is less than the radius of a demisphere.

The other thing to notice here is that, whereas I viewed the galaxy G_1 straight on, it is viewed by her at an angle. Observer 2 necessarily views *everything* in the universe from a different angle, lying at a different aspect from the original observer (unless she is on the direct line of sight between the first observer and an object).

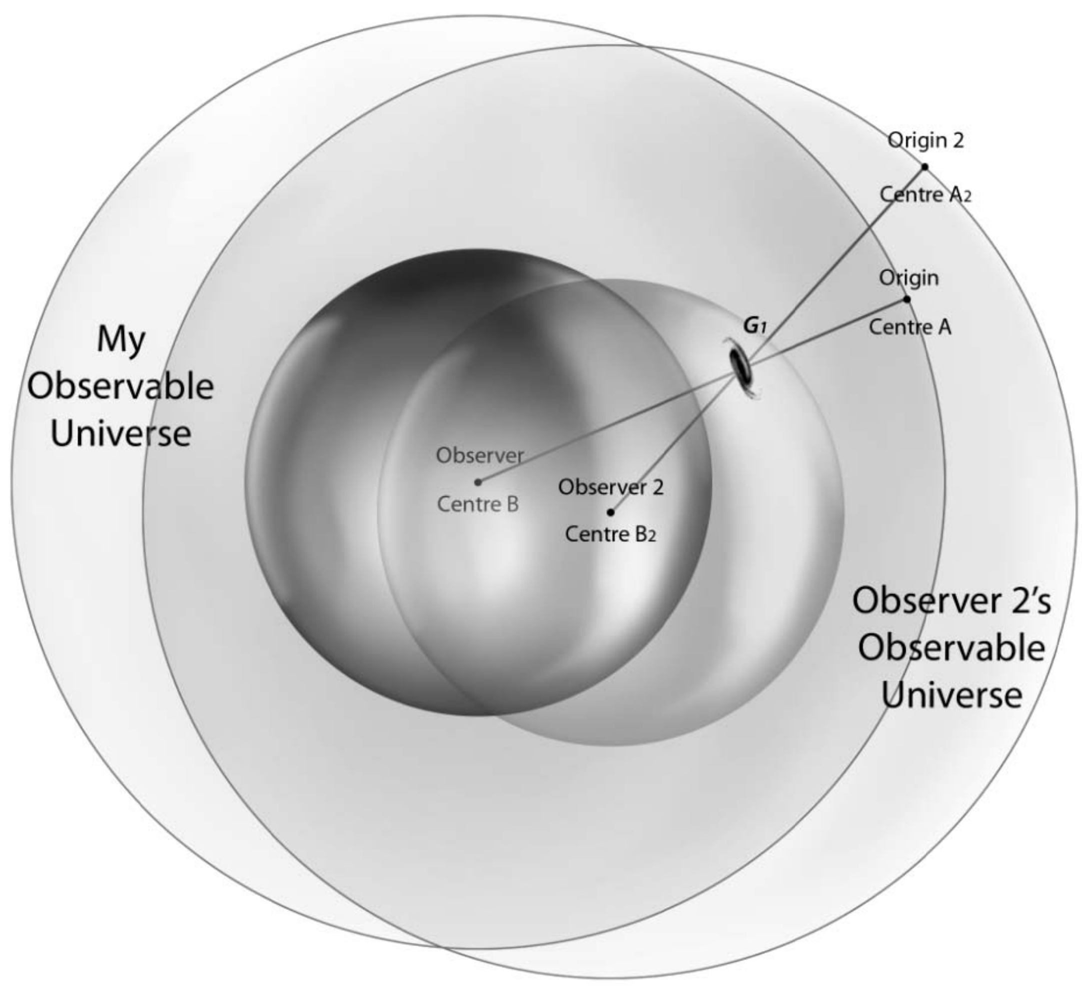

Fig.11 Now let's superimpose Λlienna's observable universe on mine. It looks a bit convoluted, but if you can separate it out, it shows the observer-centric experience of two observers approximately 4 BLY apart. Just as I do, she experiences the 4D global universe in 3D cross-section and, in harmony with the Cosmological Principle it looks the same as mine, with only one difference: she views everything from a different angle (and some things from the back, but we'll come to that).

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* A_2 is only of relevance to Observer 2. As a result, galaxy G_1, which was located in my opposite (northern) demisphere, is located in Λlienna's own (southern) demisphere.

And although Λlienna *appears* to view light originating from beyond my observable universe, when the two 'observable universes' are superimposed as per *Fig.11* her location is seen to lie within my observable universe, therefore *all that she sees must also be inside my universe*. The reason for this is that the twin demispheres are 3-Dimensionally self-contained regardless of the observer's location, and the exact 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.

In the twin demisphere model the universe is experienced by the observer as though that observer occupied the centre of the universe, regardless of the total number[a] of observer locations. In this observer-based paradigm all that exists is viewable by all, from different angles. And all within finite spherical 3-Dimensional space[b] as experienced by all.

Many Paths

In *Fig.11*, the path of light from a celestial object is viewed by each of them in different demispheres because the object is located at a distance less than a demisphere radius from one observer, but greater than a demisphere radius from the other.

However, several other geometrical permutations exist for the relative viewpoints of two observers depending on distance and whether the viewed object lies between or beyond them. These are all quirks of the 'rolling balls' effect, but they all have in common that they obey the principles outlined above – by rolling the twin demispheres through 3-Dimensions.

Reflection… It's worth noticing that throughout all this, ***the 2D equator remains physically invisible to the observer***. Or at least will not easily be detected – but we will come to that shortly.

[a] Because the stacking process comprises the deployment of discrete slices from a 'start' to a 'finish', their number should, in theory at least, be finite.

[b] It's always worth reminding ourselves that, bending due to local space-time curvature excepted, light always travels in straight lines throughout the Pac-Man universe.