Chapter 37

Net Zero

Reading the literature, it appears to be okay that two chunks of matter separated by a large but finite distance should be moving apart at a speed greater than light because, in some as yet poorly (or, more accurately, completely not) understood way, Einstein's 'speed limit of the universe' need not apply to the expansion of space itself. (Or to put it another way, something *impossible* is being explained by something *unknown*.)

As a result, because matter is at rest in relation to the space that immediately surrounds it and would appear itself to be neither expanding nor contracting, expansion's much vaunted ability to exceed lightspeed over cosmic distances emerges as an artefact of the maths; a product of what current models suggest goes on beyond unobservable cosmic horizons where space that is filled with finite things is believed to extend to infinity.

Unfortunately, other than by the introduction of a mysterious source of anti-gravity which has been given the working title of 'dark energy', the mechanisms of expansion are currently little understood. The dark energy model is associated with Einstein's 'cosmological constant' (or lambda, Λ) which he introduced in 1917 to counter-balance gravity in a universe he believed to be static[a]. However, Einstein withdrew it several years later when the universe was shown by Friedmann, Hubble and others to be expanding, and in an unguarded (but sadly now famous) moment is said to have described it to George Gamow as the 'biggest blunder of his life'. Now cosmologists have revived it as a mathematical entity and, as things stand today, Einstein's 'blunder' is believed vindicated on the grounds of certain observations.

However, nearly a century on from Edwin Hubble, the Standard Model continues to fail to produce empirically verifiable results.

Observationally

Within the Standard Model, expansion is thought to be the product of a titanic struggle going on between the twin mega-forces of the universe: gravitation and dark energy. *New Scientist* reporter Sharmila Kamat explains,

> *'...after the big bang, matter was still relatively dense in the Universe and therefore gravity braked expansion. But as galaxies moved farther apart, dark energy began to exert a more significant influence. For a brief period, two forces balanced… But then… dark energy got the upper hand.'* [b]

Dark energy exists as a theoretical counter-balancing force to gravity, believed to exist in the form of energy distributed throughout the vacuum of space and described by US cosmologist Lawrence M Krauss as *'enough energy in fact to dominate the expansion of the universe.'*[c]

NASA's website tells us,

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[a] Einstein's equations showed the universe to be either expanding or contracting. Therefore, after first consulting the astronomers of the day who assured him their observations indicated this was not the case, he reluctantly introduced the cosmological constant. The results obtained by Vesto Slipher on which Edwin Hubble would later base his work had been available since at least 1912, however, as can so often happen, they were not taken seriously.

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

[c] Lawrence M Krauss, *A Universe from Nothing*, Simon & Schuster 2012, P91

'The origin of the force that is pushing the universe apart is a mystery, and astronomers refer to it simply as "dark energy"... Determining the nature of dark energy, its possible history over cosmic time, is perhaps the most important quest of astronomy for the next decade and lies at the intersection of cosmology, astrophysics, and fundamental physics.' [a]

The online *HyperPhysics* project is somewhat more cautious, describing it as…

'…an energy density which we have not directly detected observationally' [b]

Of course, were I a cynic (which I'm not) I might be inclined to point out that other phenomena which we have *'not directly detected observationally'* include alien spacecraft, psychokinesis, ESP and hobgoblins, so, that being the case, this is perhaps just a scientific-sounding way of saying that, crucial to the model as dark energy is, there is no actual evidence for it. Science may be scathing of the supernatural, but allowances may be made if there's an equation. In this case:

$\Omega_C = \Omega_M +$ (*a hobgoblin*)

To enable the universe to expand outwards to infinity the Standard Model requires it, therefore as things stand dark energy has to exist. However, its tenure is by no means secure; like a clumsy lab assistant on a temp contract the hobgoblin is essential for now, but many physicists stand poised to let it go should its services no longer be required.

The Biggest Coincidence Ever

The Standard Model[c] tells us that expansion is the result of negative pressures induced by dark energy. The mass density of the universe may be enough to slow and eventually overcome this expansion, ultimately resulting in collapse, or it may be insufficient, resulting in runaway expansion to infinity.

Within the Standard Model…

- a universe in which there is more mass (producing gravity) than dark energy is considered positively curved – spherical – but doomed to collapse.
- a universe in which there is more dark energy than mass is considered negatively curved – saddle-shaped – therefore destined to expand forever.
- A universe where these balance out is considered flat, and infinite.

The funny thing is, all measurements to date indicate to astronomers that the density of mass-energy in the universe sits perfectly balanced on a highly improbable knife-edge between runaway expansion and rapid collapse. So the universe appears flat, and infinite. But in order to remain stable, gravitation (pulling it to collapse into the Big Crunch) *must exactly balance* dark energy (pushing it to expand and head for the Big Rip), or else… no universe. This is the orthodox version of events, however, as science writer Michael Brooks observes, no-one is 100% happy with it,

'The fine-tuning required for this will astonish you – the density of matter in space is within 1 part in 10^{57} of the required value. It certainly astonishes cosmologists, who are naturally suspicious of coincidences like this.' [d]

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[a] http://science.nasa.gov/astrophysics/big-questions/How-do-matter-energy-space-and-time-behave-under-the-extraordinarily-diverse-conditions-of-the-cosmos - Accessed 2nd Sept 2015

[b] http://hyperphysics.phy-astr.gsu.edu/hbase/astro/univacc.html - Accessed 8th Jan 2017

[c] And the endless stream of popular books based on it.

[d] Michael Brooks, *At the Edge of Uncertainty*, Profile Books 2015, P203

Put another way, theoretical physicists are not buying into it. It's simply an outrageous coincidence. So what is a poor universe to do under these circumstances? Clearly, if flatness is to stop being a problem another model is required. One clue here is that this knife-edge balance between the opposing forces of gravitation and dark energy is a struggle between something known and something unknown – like a man pulling on a rope that passes over the brow of a hill who concludes that there must be something pulling on the other side... probably a hobgoblin.

But is there?

Good News/Bad News

The good news is, the energy of the vacuum has been found to exist. The bad news? Measurements indicate that there is not nearly enough of it. Michael Brooks takes up the story,

> *'The amount of vacuum displaced by the Earth's volume in space would contain about one hundredth of a gram's worth of vacuum energy. That's how small it is. When, however, theorists work out the vacuum energy from quantum field theory, they get a number that is too big. Massively too big. Their theory suggests that the vacuum energy is so big, it should have ripped the universe apart in one massive hyperacceleration. This is known as the cosmological constant problem and is widely accepted – even by the physicists involved – as* ***the*** *most embarrassing mismatch between theory and experiment ever. A million is a big number: a 1 followed by 6 zeroes. A trillion has 12 zeroes. The mismatch between the measured and the theoretical value for the cosmological constant has 120 zeroes.'* [a]

So it's back to the whiteboard...

Since those early days, physicists have accepted that they simply do not know what dark energy is, and astronomers freely admit that before they can search for a needle in a haystack, they first need to find the haystack. As a result, observational efforts are now concentrated on gathering more precise data on the behaviour of expansion in the hope that 70% of the universe will show itself. Unfortunately, it's just possible that a wild goose may have nested in the haystack, and, sadly for the goose, swallowed the needle.

A Thrilling Strangeness

The origin of the universe was a unique event which cannot be compared to a conventional explosion. The Big Bang generated a universe which has expanded ever since, but, as Martin Rees has observed, the greatest mystery is the complete absence of a power source. Indeed, two things are not yet known to modern physics:

1) What powered the Big Bang, and
2) What gravity is.

The question therefore arises, *'If it is not known what powered the Big Bang, how do we know for sure that mass exerts a gravitational influence on the universe's expansion?'* In the absence of these two critical items of knowledge, the whole idea that gravity has *ever* exerted any influence on the universe's expansion is clearly an assumption[b].

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[a] Michael Brooks, *13 Things That Don't Make Sense*, Profile Books 2010, P26

[b] Again, just because the mathematics of GR permit it, does not necessarily mean it happens.

In addition, since the discovery in 2015 of experimentally verified gravity waves has now confirmed that the effects of gravity travel at the speed of light, the question also needs to be asked, *'How is it that something which is restricted by the speed of light (gravity) can exert influence on something that is* *<u>not</u>* *(expansion)?'* If consistency, or the lack of it, is any kind of guide there's plenty to work on here.

Although the whole gravity/dark energy scenario seems to resonate with US philosopher of science Thomas Kuhn's description of a theory in crisis[a], the UK's Institute of Physics website, *physicsworld.com*, expresses just how deeply embedded into our thinking this scenario is,

> *'Astronomers have been puzzling over the expansion rate of the Universe and its mass for decades. If the mass of the Universe is large enough, the expansion* ***will*** *eventually decrease and the Universe* ***will*** *then collapse in on itself. However, if the density of matter in the Universe is less than a certain critical density, it* ***will*** *continue to expand for ever.'* [Emphasis mine] [b]

Notice that little word *'will'* in there – how very *British* of us to tell the universe what to do! Dark energy is not so-called because of its shade, but because no-one knows what it is. As per 'space itself', something mysterious is being interpreted as the action of factors unknown. However, it's not all doom and gloom – the Hubble website takes a positive view,

> *'The strangeness of dark energy is thrilling. It shows scientists that there is a gap in our knowledge that needs to be filled, beckoning the way toward an unexplored realm of physics. We have before us the evidence that the cosmos may be configured vastly differently than we imagine. Dark energy both signals that we still have a great deal to learn, and shows us that we stand poised for another great leap in our understanding of the universe.'* [c]

Faced with such an impasse, Thomas Kuhn informed us in his classic 1962 assessment, *The Structure of Scientific Revolutions*,

> *'…normal science possesses a built-in mechanism that ensures the relaxation of the restrictions that bound research whenever the paradigm from which they derive ceases to function effectively.'* [d]

So, relaxing the restrictions, let's now compare the Standard to the twin demisphere model.

Mr G and the Hobgoblin

Currently, we assume the existence of the hobgoblin on the other side of the hill because we *know* there is a man on our side of the hill. His name is G, and he is pulling the universe to collapse back into itself. This tendency of gravity to pull the universe to collapse emerges from Einstein's equations. However, without in any way challenging Einstein, in the twin demisphere model there is no hobgoblin, so the man has no use for the rope. He is quite happy in his own company and all he really needs is a piña colada and a deckchair.

Explanation:

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[a] Thomas S Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press

[b] http://physicsworld.com/cws/article/news/1998/nov/06/evidence-mounts-that-the-expansion-of-the-universe-is-accele - Accessed 11th March 2016

[c] http://hubblesite.org/hubble_discoveries/dark_energy/de-what_is_dark_energy.php - Accessed 8th Jan 2017

[d] Thomas S Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, P25

As a closed (or, as the mathematicians say, compact) system in 4D, *the universe neither expands nor contracts due to gravitation* because – in a similar[a] way to that which would be experienced at the centre of the Earth – gravity has the ubiquitous property of cancelling itself out, regardless of local strength. As described, the twin demispheres behave as a closed Pac-Man universe. As a result, matter in space may rend and pull itself into filaments as astronomers observe, but this universal phenomenon – the cosmic web – is just the expression of local hustle and bustle in a universe that expands by a mechanism which is not the *result of* gravity, but which in fact *gives rise to* gravity as per the relativistic mechanism described in Chapter 35 (the transfer of *Centre A/B* and *B/B* information at *c*).

Due to uneven distribution, the rending and tearing of matter on the grandest scale pulls it out like steel wool – like an enormous Pac-Man sponge – but the total amount of matter viewed isotropically remains the same. Therefore, from the Big Bang down to the present day, the force of gravity is experienced on average homogenously regardless of the observable universe's size, with net gravitational pull throughout the global universe of zero. Of course there are localised lumps and bumps everywhere, but for every lump that pulls from the right, there's an equal but opposite bump pulling from the left.

Result: a universe filled with local curvature that is on average flat.

This is exactly what astronomers have found: a flat universe in which a state of universal gravitational equilibrium prevails. As such a Pac-Man universe has *net zero gravitation*, whatever its size. There is no hobgoblin, no strange and unidentified energy of the vacuum, and no highly improbable knife-edge. As such, dark energy's absence of empirical evidence stands as strong evidence for its non-existence.

This is the situation described in terms of the gravity/dark energy conundrum.

However…

This is not the whole story, because if we look more closely at the way in which mass is distributed within the twin demisphere model something very interesting is taking place…

Our man in the deckchair, Mr G, who is relaxing in the knowledge that there is no hobgoblin – i.e. no vacuum energy to drag him out of his chair – turns out to be a far more complex character than he first appears. Like most of us, he has several sides to his character. In his case they are one at each side of the hill, pulling evenly on the rope. The mysterious source of anti-gravity turns out to be, not unreasonably, *gravity itself.*

In an interview with Davide Castelvecchi of *sciencewriter.org*, this is precisely how the effect produced by 'dark energy' is described by pioneer of Inflationary theory Alan Guth where he calls it *'repulsive gravity'*, created by *'negative pressures'*[b].

Frank Close of Oxford University writes,

> *'It is as if all of space is filled with a strange sort of anti-gravity, which has become known as dark energy.'* [c]

Looking at the twin demisphere model as described through Chapters 27 and 28, its most obvious feature is that it consists in two touching spheres; so, regardless of expansion, their gravitational pull on each other is clearly *always equal*. These spheres share a surface[d], which complicates (probably to the point of

[a] But not identical, because gravity acts differently over a field to how it does at a point. There is ongoing debate among physicists about this, but in general the analogy stands.
[b] http://sciencewriter.org/alan-guth-interview - Accessed 27th Sept 2015
[c] Frank Close, *Nothing: A Very Short Introduction*, Oxford 2009, P88
[d] Remember the 'rolling balls' from Chapter 27.

craziness) the way in which each experiences the permeative gravitational pull of the other. However, considering the system as a whole, the twin demispheres exist in gravitational equilibrium, with each experiencing the other as though it were pulling away from its surface at the 2D equator in all 3D directions equally[a].

The gravitational 'knife-edge' mentioned earlier is therefore not a *coincidence* of celestial proportions, but a necessary *consequence* of the twin demisphere model.

Like two identical but increasingly oversized twins sitting on a seesaw consuming same-sized bags of donuts, all the action takes place in terms of the relationship between *Centre A* (the origin) and *Centre B* (the observer). Greater minds than I may have to sort out the finer details[b], but suffice to say that, within the cross-section that is the observable universe – replicated for each observer – the observer's northern demisphere is pulling away perpendicularly[c] across the 2D equator into the surface of the southern in all directions in 3D, generating the impression at every location throughout our (i.e. the observer's) own demisphere that a force is acting on the grand scale *contrary to the effects of gravity*.

With all the same phenomena reflected over at *Centre A*, this force of 'anti-gravity' must weaken as it approaches *Centre B*, ***tending to zero at the observer's location where only our familiar force of gravity will be experienced or detected***. In other words, the effect of the pull away from the observer exerted by the northern demisphere is spherically equivalent in all directions at the observer, increasing in influence with distance.

This accounts for our observational experience of negative pressures (currently interpreted as dark energy) as ***profoundly potent universe-wide, yet strangely absent in our locale***. As a result, the pattern of gravitational stresses from both demispheres occurring on Messier 109 will be observed by us as very slightly different to those acting on our Milky Way. However, for Messier 109 the position is reversed, as it will *itself* experience the same stresses as our Milky Way.

Reflection… How can this possibly be? That the pattern of gravity acting on a distant body in space is different for the body itself from that described by the observer on Earth who is observing it? The answer to this apparent paradox – although related to the twin phenomena of *Centre A/B* recession and *Centre B/B* propagation as described in Chapter 35 – has to do with the observer-centric shape of the universe, with potential to add a further layer of complexity for the astronomer of the future.

This – the direct consequence of observer-centricity – is quite upsetting to the current Standard Model, because without in any way altering the universe's homogeneity, or General Relativity, this renders the action of gravity itself an observer-based experience! Gravity throughout the universe must be experienced by each *Centre B* in the same way – weakening over distance whilst anti-gravity[d] 'strengthens' with distance, arriving at the fulcrum of the 2D equator where gravity and anti-gravity are equivalent, then (as the dimensional effect kicks in) pulling inwards to *Centre A*, experienced by us (by the 'Antarctica effect') as pulling *ever outward* to the surface of the observable universe.

Viewed objectively, the southern and northern demispheres exert an equal gravitational influence on one another. However, viewed around the observer at *Centre B*, the effect contributed by the northern

[a] This is the opposite direction to the CMB which streams *in* across the 2D equator from all directions equally in 3D.
[b] Of a system in which we experience cross-sectional effects in the 3rd Dimension which are produced in the 4th.
[c] Of course gravity acts at all other angles also, but these are all perpendiculars as viewed by other observers at other *Centre B's*.
[d] The gravity exerted by the northern demisphere, centred on *Centre A*.

demisphere is so far away as to be virtually negligible. But it goes on none the less, describing the universe's vast, observer-centric shape.

Reflection… Both Feynman and Sagan felt that the stage was too big for the drama… but if the universe were human drama-sized, your observer-centric experience of extra-terrestrial gravity and mine might be so different as to become problematic.

So we see that it is the *necessarily perfect* balance, set by the twin spherical geometry of a 3D cross-section of a 4D hypersphere, and maintained by these two identical counter-forces of gravity, that keeps the universe flat, because net gravitational pull – or *overall* curvature – is zero.

And, perhaps most shocking of all, this is the very same spherical universe as described in 1916 by Albert Einstein. Einstein missed its expansion, but we have all missed its shape.

MOND – the Smoking Gun?

As a champion of MOND ((MOdified Newtonian Dynamics), astrophysicist Pavel Kroupa of the University of Bonn has long endured the slings and arrows of the mainstream. He writes[a],

> *'Starting in the 1980s, Mordehai Milgrom at the Weizmann Institute in Israel showed*[b] *that a small generalisation of Newton's laws can yield the observed dynamics of matter in galaxies and in galaxy clusters without dark matter. This approach is broadly known as MOND (MOdified Newtonian Dynamics). Milgrom's correction allows gravitational attraction to fall off with distance more slowly than expected (rather than falling off with the square of distance as per Newton) when the local gravitational acceleration falls below an extremely low threshold.'*

This falling off of attraction with distance more slowly than predicted by Newton's inverse square law may describe the behaviour of gravity as it recedes from the observer into the northern demisphere[c] to approach *Centre A*. Since every point throughout the universe enjoys its own *Centre B* to *Centre A* relationship, the effect will generate a complex and ubiquitous pattern of gravitational influence centred on every point. However, as a dimensional effect, it should be more pronounced the farther from the observer objects are located. This necessarily means that it will be at its least detectable near to us and perhaps even well beyond the Sloan Survey, placing those investigating it – such as Kroupa – in the difficult position of being largely dependent on theory and computer modelling.

This is touched on briefly by Cambridge mathematician and prolific author John Barrow as *'a so-called 'fifth' force'*[d],

> *'It has been claimed that there is evidence that Newton's inverse-square law of gravitational attraction is not the true behaviour of the force between masses when gravity is weak. Rather, there is a small change in this law which is equivalent to the addition of another force to it. This extra ingredient is called the 'fifth' force, although strictly it should just be interpreted as the hypothesis of a slightly different behaviour for the known force of gravity.'*

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[a] https://aeon.co/ideas/has-dogma-derailed-the-scientific-search-for-dark-matter - Accessed 5th Dec 2016
[b] http://adsabs.harvard.edu/abs/1999PhLA..253..273M - Accessed 5th Dec 2016
[c] I cannot say whether it does – I merely venture it as a possibility in view of the fact that MOND has not 'gone away'.
[d] John D Barrow, *New Theories of Everything*, Oxford University Press 2008, P108

What this so-called 'fifth' force could be describing is a dimensional effect whereby, considered in terms of the southern demisphere, gravity might be expected to fall off normally, whereas considered in terms of the northern demisphere, gravity might be expected to intensify – or at the very least behave strangely – as it approaches the observer's 'counter-barycentre' at *Centre A*.

> *Reflection…* Remember that the dimensional nature of this effect means that the lens 'actually grows the bug'. In other words, dimensional lensing does not merely distort the observer's image, but describes the observer's reality.

If, due to the 'Antarctica effect' as discussed in Chapter 27, the distant universe is lensed[a] whereas in reality it tends to a point, this observer-centric paradox which is inherent in the 'rolling the balls' relationship of each demisphere to their shared 2D equatorial surface would not be a new force but, as Barrow says, *'a slightly different behaviour for the known force of gravity'* due to the finite universe's shape. Kroupa senses that MOND may be onto something,

> *'This threshold could be linked to other cosmological properties such as the 'dark energy' that accounts for the accelerating expansion of the Universe.'*

He continues,

> *'These links suggest a deeper fundamental theory of space, time and matter, which has not yet been formulated. Few researchers have pursued such an alternative hypothesis, partly because it seems to question the validity of general relativity. However, this need not be the case; additional physical effects related to the quantum physics of empty space and to the nature of mass might be playing a role.'*

Scattershot

Indeed the defining factors may be all of the above. Overseen by the shape of the universe, the mathematics of MOdified Newtonian Dynamics may describe something of the effects of gravity over cosmic distances approaching the hypersphere's north pole at *Centre A*. As we will consider in the next chapter, *all* the contents of the observer's opposite demisphere will be subject to the wholly new but inescapable dimensional phenomenon of '2D equatorial lensing'.

This scenario – the interpretation of existing data in terms of the twin demisphere model – is not nearly as threatening to our known laws of physics as it might first appear, because:

- It would not involve the much-dreaded *change* to General Relativity, but simply the correctly tailored application of GR within the model, and
- It would not involve a *change* to Newton's inverse square law, but, again, its correctly tailored application within the model.

It may not be Einstein or even Newton that needs adjusting, but simply our model. As Massachusetts-based science journalist Mark Anderson writes in UK's *New Scientist*[b], whichever approach to the MOND/dark matter problem one adopts,

> *'there is still a massive elephant in the room: the glaring absence of an underlying theory.'*

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[a] Beyond the 2D equator the universe appears to the observer increasingly stretched out.
[b] New Scientist, *Strangely Attractive*, Mark Anderson, 18th Mar 2017

Anderson concludes his 2017 article with a comment by Stacy McGaugh, astronomer at Case Western Reserve University in Cleveland, Ohio,

> *"We don't know where the final theory takes us, because we don't have it yet. So there needs to be a period of uncertainty and scattershot, in order to find our way forward."*

The twin demisphere model, derived directly and independently from the simple principles of EA Abbott's *Flatland*, supplies an underlying theory (along, perhaps, with a bit of scattershot!).

However, all this leaves us with another problem, because… if the universe is not set up as a gargantuan struggle between the two evenly matched colossi of gravitation and dark energy – *neither of them may be used to explain the cosmic jerk*[a]. A reason for the observed phenomenon of recent acceleration would therefore require to be sought elsewhere.

Please read on…

[a] The 'cosmic jerk' is the switching point in the expansion rate of the universe from deceleration to acceleration.