Chapter 19

Openness and Diffusion

It would be hard to overstate the proportion of ‘outer space’ in the universe. The eminent English physicist Sir James Jeans put it like this,

> *'In this model, the sun is a very tiny speck of dust indeed – a speck less than a three-thousandth of an inch in diameter... Think of the sun as something less than a speck of dust in a vast city, of the earth as less than a millionth part of such a speck of dust, and we have perhaps as vivid a picture as the mind can really grasp of the relation of our home in space to the rest of the universe.'* [a]

It numbs the mind, insignificant little humans that we are as Carl Sagan might have said. But in reality, how significant *is* the sheer vastness of the void? Earlier, in Chapter 7, I suggested that the line and the plane may not be what the 1st and 2nd Dimensions *are*, instead…

> Nature has merely represented them to us abstractly as the line and the plane because – whatever they truly are – in some way, ***they exhibit properties of the line and the plane***.

Then, in Chapter 16, a disturbingly simple process of reason led us to the 3D ‘invizicube’ – a purely conceptual object having length, width, and height constructed from (and holding the same status as) points, lines and planes – and, with help from Einstein, cast some serious doubt on the objective existence of space.

We are about to deploy the same logic in a way that will point us to a bizarrely counter-intuitive conclusion about the dimensional structure as it plays out in the real world. So let’s begin by looking at the most obvious property of 3-Dimensional space as we encounter it: ***volume***.

If, in our experience of the universe, 3-Dimensionality may be represented by the ordinary volume of space, then it is reasonable to conclude that the properties possessed by the combination of length, width and height may be generalised to apply within the 3rd Dimension proper (referred to earlier as truespace). But, in order to approach it in this way, we have to somehow bring ourselves to think of 3-Dimensionality as an entity in itself, a ‘3rd Dimension’ *to which the general principles of volume associated with the product of length, width and height apply*.

This is not easy to do. In String theory the lower three are accepted precisely as we find them and described mathematically as the ‘extended dimensions’[b] because we are accustomed to our concept of 3D in terms of l-w-h, period. However, the dimensional structure requires us to turn this picture on its head, demoting l-w-h to *representative of*, and therefore just a ‘special case’ of 3-Dimensionality. We will now attempt to prise the 3rd Dimension free from the phenomenological constraints of nature as we find it.

The Room and the Matchbox

The essential nature of ordinary 3D volume might be described as follows:

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[a] James Jeans, *The Universe Around Us*, 1953, P96

[b] As distinct from the temporal dimension, then, numerous theoretical ‘curled up’ spatial dimensions too tiny to be empirically verified.

- If one ordinary space has more length, width and height than another ordinary space, it is a greater space.

Let’s take an example:

- A room has a greater amount of space than a matchbox.

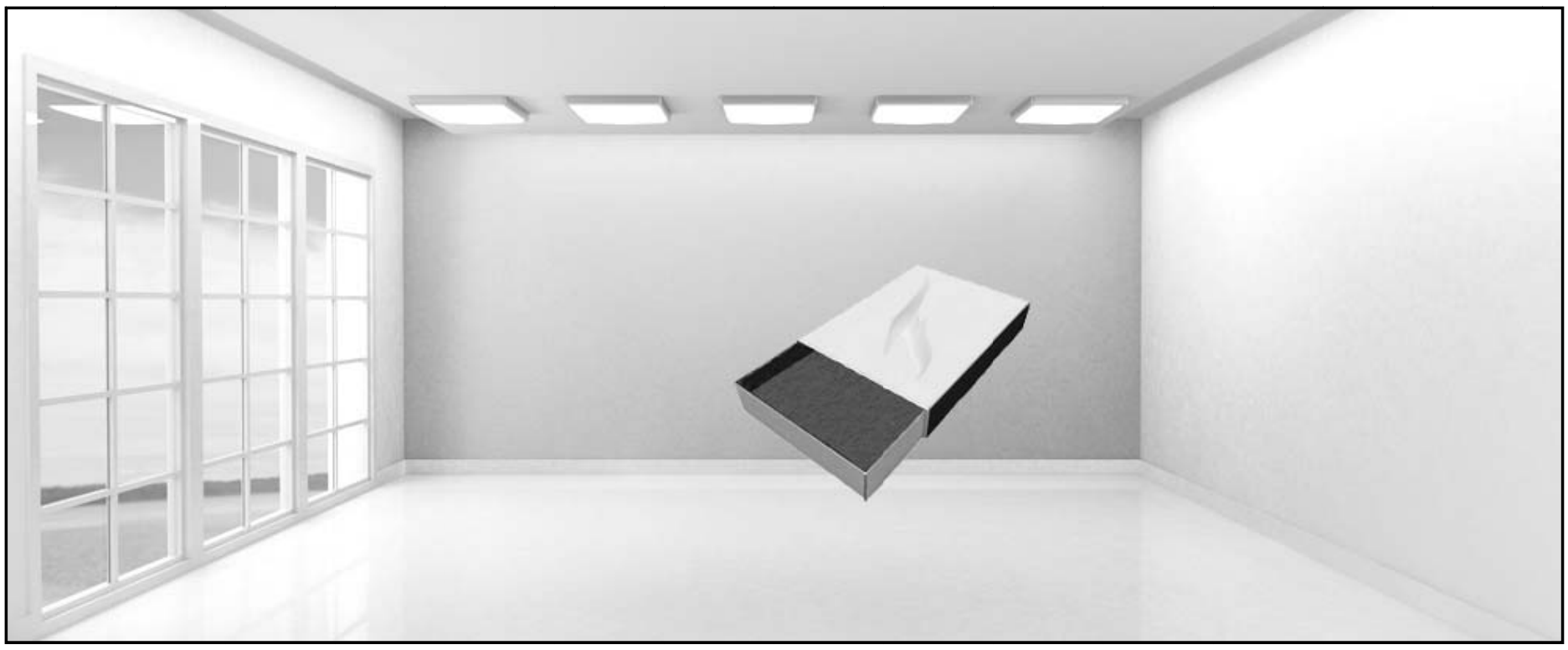

Fig.1 The room and the matchbox.

This simple principle is critical and means that if one space possesses more ‘3-Dimensionality’ than another space, it has a greater volume and is therefore a more open space.

Obvious, yes?

Ok, so applying this reasoning to the 3rd Dimension proper (using truespace to represent it):

- A big chunk of truespace is a more open ‘space’ than a small chunk of truespace, because it possesses more 3-Dimensionality.

And since the density of truespace is proportional to mass-energy (which stacks up to form it):

- The greater the mass, the more *open* the ‘space’ in the 3rd Dimension.

Although this process runs contrary to our accustomed thinking, by following the logic to its natural conclusion we find that truespace is a form of ‘openness’ in the 3rd Dimension. Consequently, ***in the 3rd Dimension proper, mass may be an indicator of openness***.

In summary:

- A massive object constitutes a *wide open space* in the 3rd Dimension,

and conversely,

- Ordinary space is *confined space* in the 3rd Dimension,

because it contains only a small amount of mass.

Here we are thinking of 3-Dimensionality as a ‘thing’: a non-uniform field which fluctuates in density throughout the universe, varying in proportion to the presence of mass-energy. This is completely counter-intuitive because we have to train our minds to think 'backwards' about volume. To avoid confusion with volume in ‘ordinary space’, I will refer to the openness of truespace as 3Dv (i.e. 3D-volume). 3Dv is

the property of volume in ordinary space, as applied to truespace. It is proportional to mass-energy and is the available truespace in the 3rd Dimension proper.

3Dv is the openness of space as mass-energy sees it.

Reflection… Although the range of terms, *truespace*, *3-Dimensionality*, *the invizicube*, and *3Dv* do not correspond to our traditional 'length, width, and height', within the universe's *Flatland*-style dimensional structure they are all aspects of the 3rd Dimension *proper* in the physical moment now.

A Falling Into

Now, let's imagine there are two massive spherical objects in space which happen to be exactly the same size, both made of iron, but one is solid whilst the other is porous like a Swiss cheese.

Fig.2 Two identical objects in space, one solid and the other porous.

What can we say about them?

- They are made of the same material
- They have the same diameter
- They occupy the same volume of 'ordinary space'
- One has more mass than the other
- The more massive one has the stronger gravity

But now, because 3Dv is proportional to mass we can add more information…

- The more massive one has more 3Dv and is therefore a *wider open space* in the 3rd Dimension

So we observe that the object which is wider open in the 3rd Dimension has the stronger gravity. Is there a connection? In gravitational terms the body with less 3Dv is falling into[a] the body with more 3Dv.

[a] When Isaac Newton first set out on his journey to change the world he began by asking himself the simple question, *"Why does the apple fall to the Earth and not the Earth to the apple?"* The answer, as he discovered, is that the Earth does indeed fall toward the apple, but only in proportion to their mass. They share an inclination to fall into and occupy the same space (their barycentre), but the Earth has far more mass than the apple so its contribution to the falling together is imperceptible.

Putting this another way, the object which in the 3rd Dimension proper is a *more confined* space, is falling into the object which is a *wider open* space.

The matchbox is falling into the room.

Thought-Experiment No.1:

- Now let us imagine that the matchbox contains only air freshener whilst the air in the room does not[a]. We open the matchbox, leave the room, then return in an hour.

What happens? The air freshener has spread fairly evenly throughout the room. Did we have to apply a force to get the air freshener to leave the box and disperse throughout the room? No, it did it by itself. Is there still air freshener in the matchbox? Yes, a little, but far more air has drifted *into* the matchbox, leaving the relative proportion the same as the rest of the room. The room and the box have become one.

This process is called *diffusion*, and (for thermodynamic reasons) it just happens. Of course, in theory it is possible for all the freshener to stay in one place, but the laws of probability are against it. In *The Number Mysteries*, mathematician Marcus du Sautoy describes the outcome of the diffusion of gas molecules in a room,

> *'You may not know at any one instance where each molecule is, but the physics says that the molecules will be fairly evenly distributed around the room. There won't be one corner with a concentration of molecules, and at another corner a complete vacuum.'* [b]

No additional force is required because all the tiny gas molecules float around and, using the kinetic energy they possess, bump into one another like the dodgems until eventually they intermingle to permeate the room. The same process is at work when you pour some coloured liquid into a bath or when kids pee in a swimming pool! Diffusion is ruled by entropy – the universal tendency of things to pass from order to disorder – because systems tend naturally toward the state with the greatest number of organisational options, which requires the least energy to maintain. This is linked to probability, and was comprehensively described by the German, AE Fick (Laws of Diffusion) and the Austrian, LE Boltzmann (Kinetic Theory) around 1870, with confirmation coming in 1905 via Einstein's paper on Brownian motion.

Is Gravitation Diffusion?

Think, if you can, of confined space as an entity in itself. A confined space in the 3rd Dimension proper is an area containing low 3-Dimensionality, (i.e. only a small amount of truespace, the equivalent of a small mass). The lowest concentration of mass-energy in our universe is found in the vacuum of outer space, therefore in the 3rd Dimension proper ***the vast expanse of ordinary space is experienced by objects as confined space***, and, regardless how much of it there may *appear* to be, is extremely constrictive. In entropic terms this confinement reduces the number of organisational options for the component parts of the truespace field[c], resulting in flow from constriction to openness.

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[a] The experiment takes place in a weightless environment with temperature and pressure the same for both gases.

[b] Marcus du Sautoy, *The Number Mysteries*, Fourth Estate 2011

[c] If the truespace field constitutes the 3rd Dimension, then our *Flatland*-derived *Principle of Stacking* tells us that its 'component parts' must be the 0th, 1st and 2nd Dimensions.

Thought-Experiment No.2:

The matchbox is now outside the room, and both the matchbox and the room are filled this time with fresh air. Let us imagine – as Einstein did when contemplating gravitation and freefall – that the walls of the room and the sides of the matchbox are removed, so that all we are left with is different sized pockets of air. These represent *open* truespaces of differing magnitudes in the 3rd Dimension proper, all surrounded and hemmed in by *confined* truespace – corresponding to the vastness of space – which effectively acts as a container around each pocket.

- As they approach one another they begin to make contact and, gradually at first, the outermost air from each begins to mingle. Because of their relative sizes, only a tiny proportion of the room-air makes initial contact with the box-air, whilst *all* the box-air drifts into the room. The box-air diffuses evenly into the room-air, so that its *average* direction of diffusion is toward the room-air's centre. Having pooled their resources they are now the same pocket of air, which is the size of the two combined.

This is a picture of how gravitation operates in the 3rd Dimension proper when a lesser mass (such as the porous spherical object) meets a greater mass (the solid spherical object) in outer space. By inverting our intuitive concept of volume we see that gravity (Einstein's 'freefall') could simply be the result of entropy in the universe. We might state it like this:

In the 3rd Dimension proper,

- All the *open space* is diffusing from the *confined space* into the *wider open space*.

Which is the same as saying,

- All the *smaller massive objects* are falling away from *space* into the *greater massive objects*.

In this way, the 3rd Dimension's main feature – 3Dv in the form of openness/confinement – acts in accordance with the universe's dimensional structure, not our natural human intuition.

Pleased to Meteor

The same process takes place when an object such as a meteor glances the Earth and has its path bent, as follows…

- Passing with great speed and momentum through the 'confinement' of outer space, the meteor's lesser truespace begins to diffuse into the Earth's greater truespace. This has the observable effect of 'pulling' the meteor in toward the Earth as it drifts along its path of least resistance. However its momentum carries it on past, bringing to an end their brief mutual intermixing, and re-sealing each 3Dv in exactly the same proportion as before, but with each having 'exchanged by diffusion' an equal amount of truespace with the other.

A meteor is therefore only able to survive a near-miss if their mutual exchange of diffused truespace in the time allowed is less than the 3Dv of the meteor (the smaller object). If it is more, the meteor has a truespace deficit, and…

- The meteor 'enters the room', caught by the Earth's gravitational field and diffusing all its truespace toward (on average) the centre of the Earth's 3Dv and crashing to the ground, thus adding to the planet's mass.

However, if their exchange is equal, then…

- They become one system and begin to orbit their barycentre (centre of mass, the ‘average centre of diffusion’), sharing the constant ongoing exchange (diffusion) of a 3Dv of truespace that is equivalent to the mass of the smaller object.

Whether or not an object in a gravitational field has its fall broken by the ground, the stacked-up energy of which it is composed continues to experience diffusion toward, on average, the centre of the widest open truespace.

The truespace of an object has no hard edge at the object’s surface and openness dissipates into confinement just as do other field phenomena[a]. This dissipation shapes the gravitational field which fills the universe because, in the words of Einstein, *'There exists no space "empty of field"'*. However, gravitation’s infinite range across the vast expanse of space may be thought of as facilitated in the 3rd Dimension proper by the shortening of the range, because, in the virtual absence of mass, outer space is ‘confined’, behaving as an extremely low 3Dv.

Reflection… Openness, like light, exists. Confinedness, like dark, does not, but is simply the lack of openness. In dimensional terms, space only has existence in terms of that which defines it (i.e. that which stacks up to form it). In principle, this is in keeping with Einstein’s view that *‘space… has no separate existence’* but *‘requires the idea of the field as the representative of reality’*.

Pastures New

Einstein concluded that,

> *'There is no such thing as an empty space,* i.e. *a space without a field.'* and… *'On the basis of the general theory of relativity,.. space as opposed to “what fills space”... has no separate existence.'*

'What fills space' – indeed what space *is* – is the gravitational field, because…

> *'It requires the idea of the field as the representative of reality, in combination with the general principle of relativity, to show the true kernel of Descartes’ idea; there exists no space “empty of field”.'* [b]

Empty space, in the logic and mathematics of Einstein, has no separate existence. He is basically saying there is no such thing. *‘So why is there so much of it that we are all overawed?’* He might answer our question with another question: So much of what? Because empty space has no separate existence. *‘But why is there so **much** of it?’*

He has already answered our question.

This is hard to wrap our heads around and our minds rebel against the logic, but seriously, how much *nothing* do we need before it adds up to *something*? How often must we times zero by zero before we get a figure? So what is going on out there? Interactions between ‘chunks’ of light and mass-energy – nothing else. Sparsely populated as it is with planets, stars and galaxies, the whole universe is just one single,

[a] As yet physics cannot say what fields *are*, successfully concentrating instead on describing their behaviour.
[b] Albert Einstein, *Relativity, Appendix 5,* Routledge 2001

immense, jostling and expanding[a] gravitational field. From everything we have deduced so far, it would appear that ***the field of truespace is synonymous with the universal gravitational field***.

This is possible because, in the Riemannian geometry of Einstein, gravity is not a 'force which acts on objects', but is simply a 'falling into'. It is therefore reasonable to think of the universe as a vast field of *constriction* within which variously-sized open spaces wander around, falling this way and that by their inclination to diffuse into all the rest.

The outcome of such an orgy of freefall would of course be a black hole of Big Crunch proportions – the biggest open space of them all! Fortunately we have dark energy to prevent that (but sadly not for long, because, as we shall soon see, the dimensional structure has no need of it.)

Diffusion and Entropic Gravity

In the interest of clarity, I offer a definition of the way that gravity relates to the nested hierarchical dimensional structure:

> *Gravitation is the tendency of all dimensions below the 4th to diffuse into (on average) the centre of the widest open 3-Dimensional truespace (i.e. the greatest truespace density or 3Dv), which is proportional to mass-energy.*

As we shall see in the next chapter, areas of greatest truespace density correspond to the curvature of space-time produced by massive objects in space. By inverting our concept of the way that volume works, the dimensional structure gives us diffusion as a device to interpret gravitational interaction.[b]

Reflection… There is an ongoing debate in mainstream physics regarding the idea of entropic gravity which centres around Dutch physicist Erik Verlinde's 2009 proposal that the equations of General Relativity may be derived using statistical arguments, as in thermodynamics. Verlinde's entropic gravity alters nothing of Relativity but rather seeks to explain why the equations have the form that they do. In that sense it is not an alternative theory of gravitation and Verlinde has not ventured to suggest what might actually physically be happening.

It is possible that statistical arguments of thermodynamics may describe the diffusion of truespace; as such Verlinde's description of entropic gravity may correspond to activity within the dimensional structure by means of the counter-intuitive openness/confinement reversal. As far as I am aware it is not known *why* gravity might behave entropically, in which case the dimensional structure could provide some philosophical insight into what may be going on.

Diffusion is well understood within physics. In 1855 the German physicist Adolf Fick derived what are known as Fick's Laws of Diffusion. These express mathematically the way in which a solute moves from a region of high concentration to a region of low concentration across a concentration gradient, which has application in everything from plastics to population dynamics. The reason these laws work is because, although each individual molecule follows a random path, with an extremely high number of molecules this

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[a] Expansion throughout the universe has an interpretation which falls naturally out of the dimensional principles of *Flatland* – a consequence of the way that light travels through its shape, as experienced by the observer. We will come to this shortly.

[b] The mechanism described in this chapter is for gravity as an emergent phenomenon. In Chapter 35 I will describe the dimensional mechanism – derived from *Flatland* principles – by which gravity propagates between point-masses. Sadly this will be unlikely to make much sense to anyone who skips the bit in between!

randomness ceases to be apparent, being replaced by a smooth and systematic flow from high to low concentration areas. But difficulties exist because, just to be awkward, not all diffusion processes follow Fick's laws (and are therefore said to be 'non-Fickian'[a]).

Gravity Fields Forever

It would seem reasonable to ask at this stage, *'If gravitation is diffusion, what 'particles' are diffusing and in what medium?'* Whether this occurs in some way as an exchange of truespace 'quanta' I am not in a position to say – if so these might be regarded as gravitons, or quasi-particles – but, as is usual in physics, the laws themselves do not demand that we identify what it *is* that is diffusing. [b]

Indeed, it is highly possible that we may never identify what the field of truespace might actually *be*. Frustrating I know, but remember that even Newton, and Einstein after him, refused to *'feign hypotheses'*. With considerable justification, many physicists today adhere to the '*shut up and calculate'* school of thought in the belief that the essence of what things actually *are* – photons, quarks etc – can never be known. The fundamental nature of God's creation remains forever God's secret, whilst the role of science is 'simply' to figure out how it all works. [c]

Einstein wrote that, *'Space-time does not claim existence on its own, but only as a structural quality of the field.'* Space-time is not an independently self-existent entity, but a description of relationships between other quantities such as the speed of light, mass-energy, momentum, distance and time. Repeatedly Einstein pointed out that all the universe's dimensional component parts are dependent for their mutual existence and function upon one other because, as he put it, the universe is *'a four-dimensional continuum that is objectively unresolvable'*. It is my belief that the reason it is impossible to completely isolate one dimension from the rest is because, as *Flatland* teaches us, like the line and the plane, each is built from the last. [d]

Gravity is entirely passive, and although we see objects being pulled mysteriously together by what in any other circumstance would be a force, entropic diffusion would certainly explain gravity's mysterious difference from the other three fundamental interactions. Going back to our illustration, if air freshener is diffusing into a room we do not say that there is some field 'exerting an influence', because the process unfolds as the system naturally falls into the lowest energy state.

By simply allowing the concept of a 3rd Dimension to obey *principles* of volume, we have been able to invert our understanding of the openness and confinement of space, thereby generating a logical account of why we are able to conclude with Descartes and Einstein that 'empty space' has no existence on its own.

But, moving these ideas forward from the realms of philosophical (albeit logical) speculation, the question we must now ask is, *'What scientific evidence is there that the mass of an object may 'contain more 3-Dimensionality' than an equivalent volume of space that surrounds it?'*

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[a] A word which demonstrates admirably why science and poetry are separate disciplines!

[b] *'At present, and unlike all other known forces in the universe, no "force carrying" particle has been identified as mediating gravitational interactions.'* https://en.wikipedia.org/wiki/Gravitational_wave - Accessed 9th Mar 2017

[c] Theology's reply might be to say that we are all just a thought in the mind of God. Who can say otherwise? Although such ideas may seem naked speculation, in theory God could imbue a dimensional structure with life in the same way as a cartoonist imbues a 2D drawing with 'life'. The cartoon has not the same life as the cartoonist, but neither has the created being the same life as God.

[d] Albert Einstein, *Relativity, Appendix 5*, Routledge 2001