2 Dimensional origins

2.1 Simple dimensionality

In order to present the dimensional boundary chord model properly, there are one or two points that require clarification. There is a definitive thread or evolution that runs through this entire model, as it attempts to form an illustrated history of the nucleus; from creation to the present. Central to this thread, is a concept that will be known as ***simple dimensionality***.

Current theories, especially the myriad of past and current string theories; work in multi-dimensional environments, originally with up to something like twenty-six separate dimensions. These have later evolved to contain considerably less, but have begun to look at additional concepts such as 'branes' and membranes for their approximation of the real world around us. *Simple dimensionality* on the other hand, looks (simply) at what can be inferred from our own experiences, within a universe that probably contains or includes some form of additional but hidden dimensionality, that is beyond those normally experienced by us.

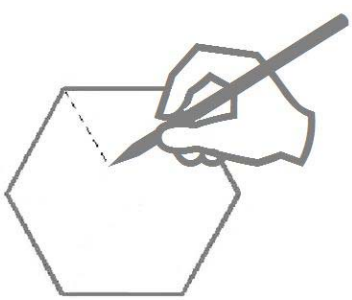

Figure 2.1.01 *A simple two-dimensional figure (a hexagon) can be dissected at its points or corners by three 'single-dimensional' lines.*

Most definitions of dimensionality are extremely abstract to say the least. We (as supposedly three-dimensional beings) are obviously quite at home with only three (and I purposely leave the fourth alone for the time being). We naturally recognize a three-dimensional object as comprised of well; three dimensions - usually defined as length, width and height (or length, depth and breadth depending on your schooling). Two and three dimensionalities are pretty self explanatory, because these appear to be simply *area* and *volume* in our terms. We also accept single dimensionality, but this is slightly more abstract than the other two. We can for example, take a two-dimensional shape (and for the sake of argument, let's choose a hexagon) and draw this area out on a sheet of paper (see *Figure 2.1.01* in the previous column).

We can manipulate this two-dimensional form by drawing straight lines between opposing points or corners, effectively dividing this shape into six, equal triangles. These lines are often used in illustration to represent single-dimensionality, although in reality, they are nothing of the sort. We now have a figure that we could say, comprises a two-dimensional form (the original *area* of the hexagon) *AND* a more *abstract* addition of lines that can here, represent simple single-dimensionality. The reader may have already spotted the deliberate optical illusion that results from this exercise - as in this trick, two dimensionality plus single dimensionality equals three dimensionality.

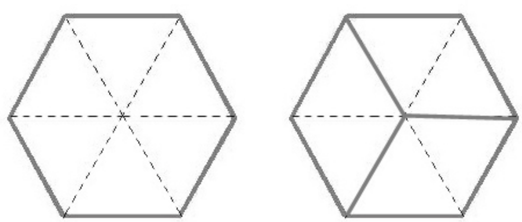

Figure 2.1.02 *The now sub-divided two-dimensional hexagon is also the illusional basis of a three-dimensional cube. Both have sides of the same length.*

It could be argued of course, that the straight lines that make up the hexagon in the first place are already single-dimensional and therefore the whole exercise is void - and I wouldn't disagree with this. In fact, any 'closed' single dimensional line will form an 'area' anyway and this will be expanded upon in the next chapter, but once this area is recognized as such, it no longer includes a single dimensional aspect; it has evolved. The addition of more (pseudo) single-dimensional lines changes things however. I have also been cheating a little, because the hexagon is one of the few two-dimensional shapes that will produce this illusion (see *Figure 2.1.02* on the previous page) and this will be seen to be very significant in due course.

My point is that there is an evolutionary relationship between these three particular dimensions and this illustrates quite well, what I have called *simple dimensionality*. Within our own experience, there is a definitive relationship that seems to connect first, second and third. That the universe includes a firm 'multi-dimensional' aspect either in its past and/or now in its apparent present, is a fact that few would now seem to disagree with. The simple illustrations in the figures above seem to reinforce the opinion that at least two of these dimensions seem to co-exist in our present universe. A two-dimensional object is simply an 'area' and both of the examples above display this property. The representation of the cube may look three-dimensional, but because we are so obviously used to 3D objects, this is merely a trick of the eye. It is still two-dimensional. The rendering would only truly become 3D if we could somehow pull the lines out of the page and manipulate them in space as though they were actually solid entities. Conversely, most three-dimensional objects (like a proper cube) can be thought of as comprising a number of two-dimensional planes, but arranged in three-dimensional space, so that their angles of incidence produce the observed 3D shape in question. The real difference lies in the fact that we are adding an additional degree of freedom to our two-dimensional area which in itself, has only two of these; usually represented by an 'x' and a 'y' axis. Our third degree of freedom adds what is usually labelled the 'z' axis and all are perpendicular to one another (see *Figure 2.1.03* above).

In our experience, there appears to be a measure of co-existence between at least the 2D and 3D worlds. There will be a good reason why we seem to have three physical dimensions within our own world and this too, will be elaborated upon in later chapters. I say physical dimensions, because this model will try to show that they are not the only ones that affect us.

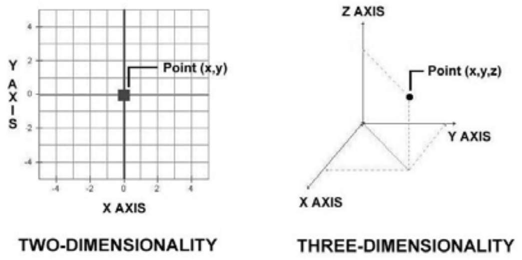

Figure 2.1.03 *The degrees of freedom that define two and three-dimensional form and their conventionally assigned axes.*

This brings us to the fourth dimension (which I purposely left to one side earlier) and this is more often than not, thought to represent the dimension of time, but this is an inaccuracy. Since Kaluza and Klein propounded their theory in 1919 comprising *four* spatial dimensions *plus* an additional dimension of time; things have never really been the same. With the advent of string and superstring theory, the matter has been complicated still further, because these comprise no less than nine spatial dimensions plus a tenth to represents time. If one also takes into account *branes* and *membranes*, it is not difficult to see that things are not as straightforward as one would have at first imagined. There may be light at the end of this tunnel of confusion, if we try to look at things in a slightly different way.

To us as three-dimensional beings, our concept of time may have been influenced by events that have themselves, had a consequence on the very evolution of this phenomenon we call time. We observe no definitive connection between past, present and future and while we know there is a logical connection (cause and effect), we cannot *directly* peer into the past and view these events as they happened - not in the past, but only *right now*, as part of our present (the effects of distance and the speed of light aside for the moment). It is also somewhat blatantly obvious that it is impossible to view events that haven't happened yet, even mere nano-seconds ahead of us in our future. This is not to say that things were not different at some earlier evolutionary stage. A specific *timeline* may have been just that, a continuous vector (or single-dimensional string), comprising past, present *AND* future, whose interaction with other phenomena caused a break or separation leading to our present concepts and observations where past, present and future are now separate entities all together. This will be explored more fully in the next chapter. As a footnote, it seems more logical to call the first-dimension 'the dimension of *time*' and to treat this phenomenon as what may have been the *original* fundamental string.

2.2 Dimensional differentiation

With so many *new* dimensions hanging around within physics these days, a viable definition of the fourth may be quite difficult to find, but I will try to show through argument, that we actually witness this fourth-dimensional level *as the expansion of the visible universe* in which we are both buoyed and supported. We should also assume a central role for the processes of evolution, which must also be applied to what can be termed ***integral dimensional levels*** - that in turn, probably make the universe what it is. This kind of changes everything, because we can arrive at a scenario that can involve rather *MORE* than just a simple 'three-dimensional' origin, currently believed to have begun with the big-bang and its subsequent differentiation through cooling. Also, by allowing a form of ***dimensional differentiation*** to occur, the origin of all the material that we define as the 'bulk' of the universe can be more easily assimilated into this model. It can also provide a definitive provenance that connects the past to the present day. This also provides a few surprises along the way, where this dimensional differentiation heralds a few jumps and drops within the evolutionary process of the early universe (see *Figure 2.2.01* opposite). I should try to say a little more about how I would define this dimensional differentiation and how I would envisage it to occur in this perspective. This is actually, quite important to this working of this model and can basically be described as a ***phase change***. This will be discussed more fully in coming chapters, but suffice to say that I picture its processes to be not unlike those that occur here on earth - especially during periods of volcanism, where this particular process is known as ***fractional crystallisation***[1].

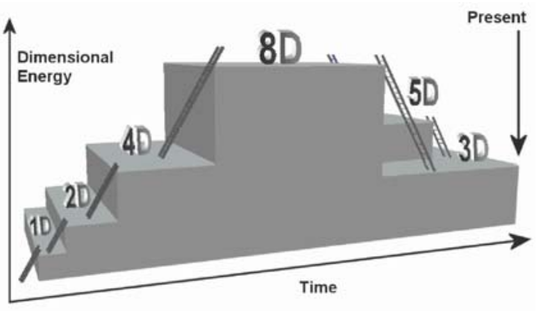

Figure 2.2.01 *The route to this model's multi-dimensional universe. The ladders show the jumps and drops over time.*

Due to ocean floor spreading, plate subduction or crustal weakening, a mass of rising magma may collect in a magma chamber some kilometres below a potential volcanic vent; usually because of a drop in pressure and therefore density. If contained long enough without being forced to the surface, it will sometimes undergo this process of *fractional crystallisation*. As the magma cools, (which is often associated at depth with a drop in pressure because of its rise towards the surface), high temperature minerals condense out of this original, *parent magma*. These condensates form dense crystals of *mafic* material, which are basically *ferro-magnesium* minerals such as olivine, which have high melting points and densities that are usually above 2.8 - 3.0 gms/cm^3.

As these crystals appear (as the magma mix cools to around their solidus), they use up a great deal of the denser material that originally made up the parent magma and they will therefore eventually become denser than the remaining magma in which they now find themselves suspended. These *cumulate crystals* as they are called, will now tend to sink to the bottom of the magma chamber, as they are much denser than the remaining liquid (see *Figure 2.2.02* below).

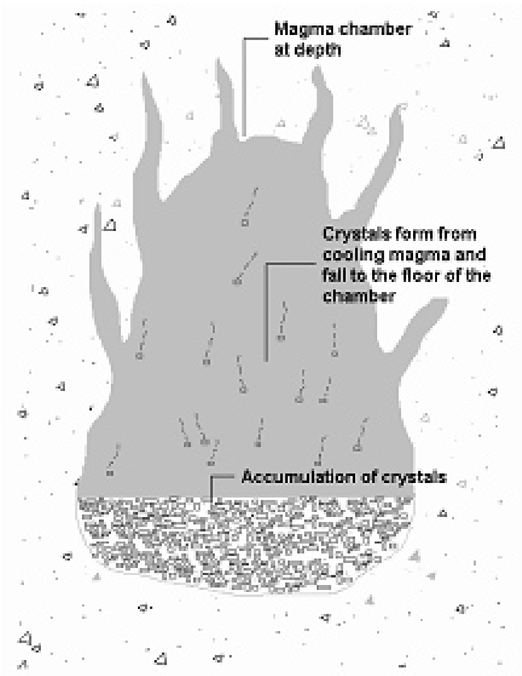

Figure 2.2.02 *Diagram of basic differentiation by fractional crystallisation at depth. As the magma cools, dense crystals form in the liquid and sink to the bottom of the chamber. The remaining magma is now depleted in the higher temperature minerals.*

The molten magma that is left over is both cooler *AND* now depleted in the denser ferro-magnesium minerals and any further crystallisation (as the magma continues to cool), will result in a mineral composition that is fundamentally different than before; now devoid of the bulk of this denser material. Fossil remnants can often be found of ancient magma chambers, the volcanic roofs of which have long been eroded away.

The tell tale sign that they are indeed the remains of these ancient structures, are a mineral banding that can be observed within their rocks which can often show quite well, the large, dark crystals at what is presumed to be the base of these structures.

These dark, dense mafic minerals slowly give way to lighter, less dense inclusions, until they may disappear altogether the higher up the formation one goes. These ancient magma chambers are often tilted because of the actions of plate tectonics and can lie at an almost horizontal inclination and the scale of such structures can cover several kilometres. Similar processes can also occur within erupting lavas, which can often deplete a parent magma of these denser minerals simply because of the fact that this eruption is removed from the original mass from which the lava came. The result will frequently cause a phase change in the material that remains. Any further eruption of magmas (usually over a timescale that can run into the many thousands of years), can be quite fundamentally different from the composition of the original lava flow and similarly, definite banding can often be observed in areas where repeated eruptions have occurred. This is especially the case with the flood basalts associated with areas of sea floor spreading, where repeated lava flows are occurring almost continually.

There may indeed be a considerable amount of difference between what happens here on earth *AND* dimensionally speaking at what may have been the differentiation of our universe perhaps tens of billions of years ago. However, processes are processes and there is no real reason to believe that physics has changed that much. The processes we observe now in any particular setting, must be comparable to similar processes in its past (its origin and evolution), as well as determining what will happen to it in the future. Our current universe must therefore possess a definitive provenance that we have yet to fully understand. The great Scottish geologist James Hutton was the first to grasp the principle that by *'studying processes in the present, infer the nature of those in the past'* recognizing the cyclic nature of geological changes in his book ‘Theory of the Earth with Proof and Illustration’ (1785). The equally great Charles Lyell, who in 1830 published his landmark work entitled

'Principles of Geology', propounded his ***Principles of Uniformitarianism***, reiterating Hutton's idea that *'the present is the key to the past'*. Although this is geology talk, I can see no real reason why the same principles should not be applied to cosmology. After all, the physical processes we observe today, such as those that occur within the core of stars must be at least similar in many respects to the processes that also occurred billions of years ago. The protons, neutrons and electrons that make up the elements within these stellar cores are experiencing changes and events that must be inexorably linked to the origin and evolution of the universe itself. Lyell's *principles of uniformitarianism* work here too and there must exist, an unbroken connection between a proton, a neutron or electron now, in the present - and similar entities (if not the same ones) way back into the past. There must be a connective *provenance*.

Fractional crystallisation or *dimensional differentiation* will involve the exchange of energy, as I doubt whether the laws of thermodynamics will have changed very much over time either. We already take for granted the fact that matter and energy are interchangeable and we are also familiar with the three phases of matter (or four if you include the plasmas); but with a universe that has experienced episodes of dimensional differentiation in its past, an energy exchange - or ***dimensional energy*** exchange - would need to have occurred. There would have been phase changes within this early environment and with *differentiated levels* of dimensional energy; we are presented with the possibility of *boundaries***,** but more about these animals later.

2.3 Measuring dimensionality

With a universe comprised of *integral* dimensional levels, we would require a definitive measure of *dimensional energy* and this is actually a lot easier than it sounds. This would simply be the process of applying different (arbitrary) energy values to differing complexities of dimensional form. A single-dimensional entity for example, would contain or comprise less dimensional energy than a two-dimensional body, which in turn would be less energetic than a three-dimensional form. As we already have a distinct (geometric) relationship between the three (physical) dimensions that so obviously make us what we are, the difference (or ratio if you like) between these required energy values, is quite easy to represent visually - and this can be achieved with the assistance of the humble cube (see *Figure 2.3.01* below).

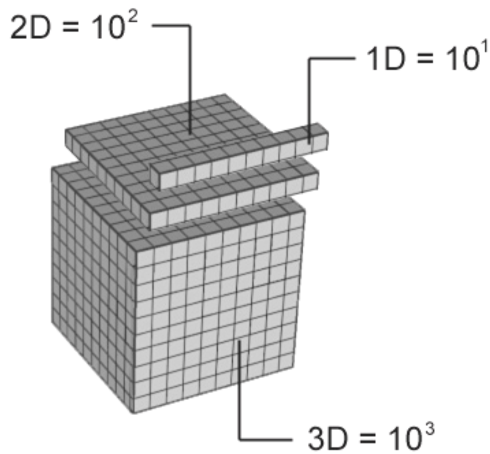

Figure 2.3.01. *Like length, area and volume in our world, the relationship between first, second and third dimensional energies can be likened to the values of a cube.*

If we consider the cube in the lower part of the illustration to be representative of single, two and three-dimensional energy levels; we can see that it would be possible to construct a straight, (single-dimensional) line with all the smaller cubes that make up the edge of a single side. In this instance, this line would contain 10 of the smaller cubes (or let's say 10 units). This line can therefore be given a value of 10^1 units. A two-dimensional value would be length times breadth, or in this example, 10 units by 10 units (or a total of 100) or 10^2 units. Likewise, a three dimensional value would contain *ALL* of the smaller cubes that make up the original or 10 x 10 x 10 units (a total of 1000) or 10^3 units. Therefore, the relationship between first, second and third-dimensional energy levels would follow this simple rule, where each is an order of magnitude greater than the one below it.

How would a multi-dimensional universe evolve and differentiate to result in the one we witness around us today? Would it start with a multi-dimensional component - or would it evolve each of its integral dimensional levels in a specific order? A clue to these questions may lie within what has already been described as *simple dimensionality*. Although more of a 'parlour-trick' than a proper argument, our toying with a paper hexagon does however, infer a kind of evolutionary process that builds from (an illusionary) single dimensionality, through two-dimensional area and up to the appearance of an apparent three-dimensional form. This would also seem the most logical solution, but we must apply caution here because we are beginning to step into unknown territory.