Chapter 6

Representations

Look for a moment at this equation: $P_n + N - 3b = p / 2$

You don’t have to figure it out… here’s a story instead,

> *Four handsome elephants by the name of Bartholomew, Norman, Bertie and Blimp were crossing the savannah. As they trudged along they met a particularly graceful and attractive giraffe named Penelope who, as the journey was long, was happy to accompany them. Although the guys much preferred elephants, there were none there, so each in his own way began to take rather a shine to Penelope. She was flattered by their attentions but, predictably, preferred her males of a slimmer build. If she was honest however, she had to admit that she enjoyed conversing with Norman more than the other three.*
>
> *Noticing this, Bartholomew, Bertie and Blimp grew jealous and, arriving at a fork in the road, struck out on their own, leaving Norman and Penelope to their uncertain future of mutually unrequited love.*

I wonder if you noticed that the equation at the start was a ‘shorthand’ representation of the story: P_n is Penelope (where n represents her inclination toward Norman), N is Norman, the three b’s are the guys, and p is the path that got divided in two. Once you spot that these are all in there, it pretty much makes sense. In much the same way, mathematicians and physicists represent quantities in the universe using numbers and letters, as explained by Brian Cox and Jeff Forshaw,

> *‘The key thing to appreciate is that for a physicist, equations express relationships between “things” and they are a way to make precise statements about the real world.’* [a]

The Equation That Time Forgot

This is the Wheeler-DeWitt equation we touched on in the last chapter – a 1960s effort at merging Quantum Mechanics with Relativity. It seems quite short (considering it sums up the universe) but some of those little symbols in there represent whole other swathes of maths. Mathematicians and physicists are to equations as translators are to their second language or as skilled musicians are to their instrument, and there is no fast-track to the kind of expertise that they have developed. However, there is a problem: physicists often cannot be certain whether their equations describe reality. Happily, according to Ian Stewart, mathematicians don’t have this problem because, unlike physicists,

$$\frac{\partial^2\Psi}{\partial a^2} - \frac{6}{ka}\frac{\partial^2\Psi}{\partial\Phi^2} - \frac{144\pi^4}{k^2}\left(a^2 - \frac{k}{3}a^4 V(\Phi)\right)\Psi = 0$$

> *‘Mathematicians don’t worry about what things* ***really*** *are. They just want to find effective ways to work out what they can do.’* [b]

But sometimes the mathematicians uncover stuff the physicists can use, as Riemann did for Einstein.

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[a] Brian Cox & Jeff Forshaw, *Why Does E=mc²?*, Da Capo 2009, P22

[b] Ian Stewart, *Flatterland*, Pan Books 2003, P49

Pancake World

We who inhabit a universe of more than 2-Dimensions can easily conceive of *A Square's* world. It is flat, so no big deal. Many things in our experience are flat, such as pancakes, paper or gold leaf. But a 2D world is not flat like any of these, because in reality pancakes, paper and gold leaf are all 3-Dimensional objects. In the case of gold leaf thickness is measured in the low hundreds of atoms, but it wouldn't matter if, like graphene, it could be just *one* atom thick, it would still be 3D, because it would still have the height of one atom.

EA Abbott said the Flatlanders were *'very much like shadows - only hard and with luminous edges'*. Actually he invented the idea that they had edges, because they were *exactly* like shadows. At this point the real world that we see and touch goes out and mathematics kicks in, because *a 2D plane is 100% theoretical*. We imagine it, but though we searched from the pyramids of Egypt to the flag on the Moon we would never find it, because our concept of 2D as 'flatness' is actually a *mental representation* of the 2^{nd} Dimension, which doesn't exist in the real world.

Elegance

It is often said that mathematics is the only exact science, and yet in this well-informed age even an equation that works may not be sufficient. An equation these days has to be simple, ideally beautiful, or best of all… *elegant*. This appeal to elegance is not just an attempt by scientists to muscle in on the turf of artists and poets – it can actually work. Listen to the words of the Nobel Prize winning physicist Murray Gell-Mann,

> *"Three or four of us in 1957 put forward a partially complete theory of the weak [nuclear] force, in disagreement with the results of seven experiments. It was beautiful and so we dared to publish it, believing that all those experiments must be wrong. In fact, they were all wrong."* [a]

Amazing! Beauty triumphs over experiment – even in science. But there are degrees of elegance. Were it possible – and I am sure that the world is filled with men who wish it were so – to somehow write down equations to describe a woman, they could never even *begin* to convey her beauty and elegance (assuming she has it to start with). The beauty and elegance of a woman and the beauty and elegance of an equation are two different beauty and elegances. Of course this is so obvious that – with the possible exception of Sheldon Cooper – no theoretical physicist would attempt to represent a woman as a calculation. However, interestingly, the Russian writer Leo Tolstoy showed it may be possible to represent a man:

> *'A man is like a fraction whose numerator is what he is and whose denominator is what he thinks of himself. The larger the denominator the smaller the fraction.'*

Incomplet…

Mathematician and philosopher David Berlinski observes,

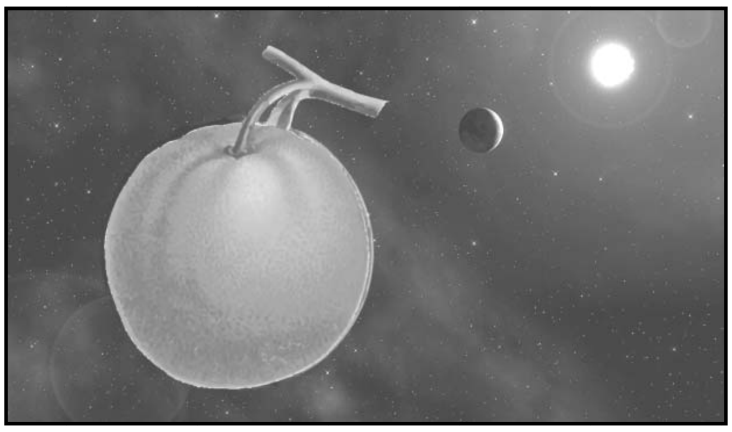
[a] http://www.askamathematician.com/2012/06/q-are-beautiful-elegant-or-simple-equations-more-likely-to-be-true - Accessed 15^{th} Oct 2016

'…Kurt Gödel demonstrated that mathematics was inherently incomplete. If science in the twentieth century has demonstrated anything, it is that there are limits to what we can know.'[a]

Maths and physics, it would appear, are insufficient to put forward a true theory of everything. Therefore, by definition, the scientific 'theory of everything' can only be the 'theory of everything scientific', and although most of the universe appears happy enough to play along, much of it is not. Consciousness, for example. The blackboards of academia may be coated in the structure and symmetries of this and other universes, but what about the *meaning?* Can the answer to the question of 'life, the universe, and everything' ever really boil down to '42', as the great computer *Deep Thought* concluded?[b] Douglas Adams' brilliant send-up is brilliant simply because we all know it can't. Physicist Michio Kaku lets Schrödinger's cat out of the bag,

'Even experienced mathematicians and theoretical physicists who have worked with higher-dimensional spaces for years admit that they cannot visualize them. Instead, they retreat into the world of mathematical equations.' [c]

Representations have immense value, but only if they are recognised for what they are. A representation is *not* the thing that it represents, any more than a US diplomat is the President, or an orange is the Earth. If we wish to study dimensions *purely* in terms of mathematics – as is the custom – we must acknowledge from the outset that this is a very severe limitation. Life is more than numbers and reality is not just a set of equations, and if, as Einstein hoped, the principle of the universe turns out to be simple, *it will not necessarily be because it has been boiled down to a formula*. The mathematician who, lost in contemplation, drives home late at night only to discover a note from his wife informing him that she has gone forever, would search in vain for the reason through the works of Pythagoras, Hilbert or Penrose…



He may be super-intelligent, but he's not stupid.

Deceived by the Device

It is wonderfully convenient to use a sheet of paper to represent 2D because it is flat, but a sheet of paper has length, width, *and* a tiny sliver of height, by which stationers categorise different qualities of paper and card. In other words, a sheet of paper is not actually 2D, but a 3-Dimensional object. In the same way, a pencil line is not a 1-Dimensional entity but a *representation* of a 1-Dimensional entity. And the same goes for a dot as a 0-Dimensional point. Unless the line or point in question is in your imagination, they are in reality all craftily disguised 3D representations. And, it gets worse… if you stare at them for any length of *time* you will prove that, as representations, they are well and truly *4-Dimensional!*

So precisely what is a representation? I will attempt a definition: a representation is a depiction of something within one dimension which expresses something of the character of that thing in another dimension (or the same dimension). There's a principle at work here wherein it would appear that any

[a] David Berlinski, *The Devil's Delusion*, Basic Books 2009, P218
[b] Notwithstanding its request for further clarification of the question!
[c] Michio Kaku, *Hyperspace*, Oxford University Press 1999, P10

dimension may be represented within any other dimension, with its fundamental properties preserved. At the very least this principle might be exploited, if not to reveal what the dimensions are, at least to reveal what they are not, because, speaking metaphorically, if a dimension were solid gold a representation is just iron pyrite, and careful discernment must be exercised not to confuse the two. If we are going to get any kind of handle on what is really going on we are going to have to be ruthless in our culling and rejection of dimensional preconceptions that seek to trip and waylay us at every turn.

As an example, you may have heard of the hypercube, also known as the tessaract. Fascinating though these are, this may perhaps be the first book on geometrically-based dimensions *not* to discuss their shape in detail. Mathematicians play around with computer-generated 5-, 6-, 7-, 8-plus-Dimensional entities, but aside from their entertainment value at certain kinds of parties, how much real significance do they have? It is my belief that – like the orange and the ambassador, the equation and the sheet of paper – they are all merely *representations of something else*.

I am interested in the something else.