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An Exploration of the Fourth Dimension

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Picture several men chained in a cave, so that they have never seen the light of day. In fact, the only things that they have ever known are the shadows picture on the cave wall in front of him. Behind these men is a fire, stationed so that these men can still only see the shadow of the fire on the wall in front of him. They can hear each other and can hear the sounds bouncing off the walls all around them, but they know nothing other than the sight of the shadows on the wall in front of them. This scenario is called Plato’s allegory. It is logical to conclude from here that these men, these prisoners, simply think that they are their own shadows. While reality appears to be one thing to these men, there is in fact a whole other dimension to which they have not seen. Reality as they know it does not allow for these men to know anything other than shadows (The Fourth Dimension: A Guided Tour of the Higher Universes 8-9). This begs the question, is there a reality out there to which we are not capable of seeing? Can there be a dimension higher than the three dimensions we think we know? There are several different theories of higher dimensions, including time as the fourth dimension, a spatial fourth dimension, and parallel universes comprising the fourth dimension.

One cannot discuss the fourth dimension, however, without referencing the book Flatland, written by Edwin A. Abbott. Plato’s allegory predates the writing and conceptualization of Flatland, but this book made big strides in developing theory behind the fourth dimension. Flatland, while on some levels is a commentary on the Victorian society from which Abbott came, it also tries to help the reader picture the fourth dimension in relation to the third dimension, by discussing the third dimension in relation to the second dimension (Geometry, Relativity, and the Fourth Dimension 4). Flatland is a two dimensional plane where creatures simply slide about to move. In this Flatland, the lower classes are the triangles with...
two equal sides. The closer a triangle gets to an equilateral triangle, the closer he is to moving to a higher class. As soon as a triangle becomes equilateral, his future children have the ability to gain sides, where the more sides that one has, the greater that shape’s social standing is (The Fourth Dimension: A Guided Tour of the Higher Universes 11-13).

The most significant part of Flatland, for the purposes of this discussion, is when a sphere comes to Flatland. The main character of this novel, A. Square, encounters a sphere, which appears to him as a circle, the obvious two dimensional cross section of a sphere. At first, when the sphere is intersecting the plane in exactly one spot, the sphere will appear as a dot to any creature in Flatland. However, as the sphere traverses the plane more, this circle will grow and grow, and then eventually start to shrink again, until the sphere completely leaves the plane. This gives the sphere, when passing through Flatland, the ability to pass in and out of a completely closed room, and in essence “pass through walls.” The Sphere also has the ability to sit above the plane that A. Square exists in, and look “inside” of him, by looking down at the rest of the plane. Take this same idea of A. square encountering the sphere, and apply that to the fourth dimension. (The Fourth Dimension: A Guided Tour of the Higher Universes 13-18).
Picture a man sitting in a room in the third dimension. This room is locked, so that there is no way in or out of the room. If there were a fourth dimensional creature, this creature would be able to traverse our three dimensional world and pass through, so that we would see simply a series of three dimensional cross sections of this figure, but never fully seeing all four dimensions. In the same way that the sphere could look down on the two dimensional plane and see inside of the square, this four dimensional creature would be able to look down on the three dimensional world and “see inside” of the three dimensional creatures (*The Fourth Dimension: A Guided Tour of the Higher Universes* 18-19). One can also consider an egg, not cracked, with the yolk still inside. A fourth dimensional creature would in theory be able to enter the egg and remove the yolk without even cracking the shell of the egg (*Geometry, Relativity, and the Fourth Dimension* 9-10).

Around the time of the spiritualist movement in 1900, there was an idea floating around that spirits or ghosts were fourth dimensional creatures. In the way that four dimensional creatures can theoretically pass through the third dimension and at some points leave the third dimension, spirits that can appear, leave, and then reenter were considered by some to be fourth dimensional creatures (*Geometry, Relativity, and the Fourth Dimension* 10). This idea that ghosts and spirits were four dimensional creatures was popularized by Johann Carl Friederich Zöllner. Zöllner fashioned several tests that would in essence prove the four dimensionality of the spirits. Most scientists of the day were not convinced by Zöllner’s work and discredited his work. While the scientific proof for Zöllner’s work was never founded, many still held on to the idea of spirits as existing in another space as plausible. This idea was transferred to Christianity, where some began to imagine that heaven, hell, our souls, the
angels, and God himself existed in a dimension higher than our own (Geometry, Relativity, and the Fourth Dimension 51-56).

There are several different types of higher space, including the spatial fourth dimension, time as a higher dimension, the existence of parallel universes as a higher dimension. The first of the higher dimensions to consider is the spatial fourth dimension. Consider figure 1 below, which is simply a line segment $\overline{AB}$. We can construct a square by moving the segment in the motion that is completely different than that of segment $\overline{AB}$, leaving all remaining vertices at a right angle, thus forming square ABCD. We can continue this idea by constructing a cube, by extending square ACBD in the direction completely different than that of the square, forming a cube ABCDEFGH, where all line segments form a right angle with each other.

(Hinton and Rucker 7)

We can then continue this idea to the fourth dimension, where we extend the cube that we have in a direction completely different than the 3 directions we have represented currently. Charles H. Hinton has gone so far as to define these directions as $ana$ and $kata$, similar with our directions up and down (The Fourth Dimension: A Guided Tour of the Higher Universes 26). We can hypothesize that in this new fourth dimensional cube, which we will call the hypercube, all segments are still at right angles to each other (Hinton and Rucker 7-8).
In addition to the discussion of the hypercube, we can discuss the hyper sphere in the same way. We define a sphere, in any space, as the set of points P whose distance from O to r is r, where O is the center, and r is the radius. When we fulfill this specific set of requirements in the second dimension, we get a circle. When we do this in the third dimension, we get a sphere, and in the fourth dimension we get a hypersphere. Just like with any four dimensional object, as it passes through the third dimension we will see some cross section of the fourth dimensional object (*The Fourth Dimension: A Guided Tour of the Higher Universes* 29-31).

There are many scientists who believe our three dimensional space to be curved. To better understand this idea, we again must look to two dimensional space in relation to three dimensional space. Consider the planet earth. No one will deny the fact that the earth is more or less a sphere, in three dimensions. However, the surface of Earth is flat. Any three dimensional surface has what we call a surface area, and in the case of a sphere, this happens to be a curved plane. We can take this idea of the curved two dimensional surface of a three dimensional space and apply that to the fourth dimension. In space there are three dimensions. It is there plausible to apply this same logic to the third dimension, and conclude that our three
dimensional space is merely the curved surface, hypersurface, of hypersphere in four dimensional space (*The Fourth Dimension: A Guided Tour of the Higher Universes* 31).

Say that I started walking East on the surface of the earth, and I continued due East indefinitely (ignoring the fact that oceans and other bodies of water might get in the way), everyone would agree that I would eventually get back to my starting point, however returning from the West. We know this because the surface of the Earth is curved and located on a sphere, and therefore circular. When we consider this same idea in relation to three dimensional space, if we were to leave Earth in a rocket travelling away from the north pole indefinitely, and three dimensional space was truly curved, we would be able to continue in this same direction, without turning around, and eventually get back to the south pole. Many scientists seriously believe that our space is curved, Albert Einstein being one of the first people to put this idea out there (*Geometry, Relativity, and the Fourth Dimension* 36-39).

What does this mean, however? If three dimensional space is merely the hypersurface of a hypersphere our space is no longer infinite, but is still without boundaries. This lack of infinite space implies that there are no longer an infinite number of stars, planets, and populations within this specific space. No matter which way you moved in this three dimensional space, you are in some way eventually moving closer to your current location. However, if all of known space is located on a single hypersphere, what exists beyond this hypersphere? Could there be other hyperspheres and other space beyond what we know? The possibility of the fourth dimension leads us to ask whether or not there could be other alternate universes or other parallel universes. The limitation and problem with this consideration is that we cannot leave our three dimensional space, because we cannot move in
the direction of the fourth dimension, *ana or kata*. In order for us to enter a higher spatial dimension, we must exert a force *ana or kata*, which is physically impossible for us at this point in time (*Geometry, Relativity, and the Fourth Dimension* 39-40).

One concept that we often see in science fiction movies especially is this ideas of parallel universes. There are several different theories about this concept of parallel universes. One theory says that there are two, ten, or infinitely many universes all parallel to the one we are in. In some of these cases, the beings can move from universe to universe, where they are conscious of all these universes, and make a conscious decision about what universe they want to live in. In other cases, we exist simultaneously in all of the universes. One example of a parallel universe is the astral plane, where people believe that our astral bodies live. According to some of the theories, our astral bodies sometimes mimic our actions. At other times, these astral bodies can act independently of our own, for instance when we dream. While there are many theories about parallel universes, there is a reason that these appear only in science fiction movies. There is no proof or convincing evidence that any sort of parallel universe does exist (*Geometry, Relativity, and the Fourth Dimension* 40-41).

Even though we have these alternate universes, how do those theorizing about them propose we get there? One way we can get there is through traveling *ana or kata*. Since this is physically impossible, we look to the idea of magic doors as portals to alternate universes. One theory of travelling to alternate universes is through something called a hyperspace tunnel, also known as an Einstein-Rosen bridge. According to this theory, the hyperspace tunnel would look like a shrunken sphere, with the entire universe contained in it. In theory, an Einstein-Rosen bridge could come into existence if there were an object dense enough to bulge space enough
to touch another space, and the denser the matter, the more that space will distort and bulge.
According to Einstein’s theory of gravity, part of his theory of relatively, Matter and Energy distort space, and distortions of space affect the motions of matter and energy (The Fourth Dimension: A guided tour of the Higher Universes 79). These two spaces might then join together.

One way to create matter this dense is through a collapsed star. As stars age, they start to cool, which means that there will be less outward pressure on the star, which consequently means that gravity can make the star smaller and more dense. If these stars contract too fast, they have the potential to explode and form a nova or supernova. If this star is not that big to start with, this star might contract and shrink to a solid lump of metal. The larger the star is to begin with, the denser the metal in this solid, neutronium, becomes, and in some cases eventually is crushed. If this material shrinks down far enough, black holes are formed. The gravitational pull in black holes can be so forceful that not even light can escape. So if one of these black holes is large enough and distorts space enough, it is possible that an Einstein-Rosen bridge could be created (The Fourth Dimension: A Guided Tour of the Higher Universes 119-120).

In addition to the theories previously stated, concerning the spatial fourth dimension, and the curvature of three dimensional space on the surface of a hypersphere, there is also a prominent theory of time as a higher dimension. Before we discuss space-time, or time as a higher dimension, we must first discuss some of the issues surrounding the compatibility of these ideas and some of the ones we have discussed previously. The idea is that all three dimensional objects are actually trails in four dimensional space time. However this does not
necessarily mean that there is not a spatial fourth dimension. There is still the possibility of the three dimensional space we live in, a fourth dimension that our three dimensional space is curved in, and still yet another dimension, let’s call it the fifth, that is space-time. Many of these ideas we have discussed about the spatial fourth dimension are not valid if we consider time alone as the fourth dimension (Geometry, Relativity, and the Fourth Dimension 58).

As we have been doing, let’s look to the second dimension to help us understand time-space as a higher dimension. We can use the idea of Flatland to help us envision the idea of space-time as a higher dimension. Picture a square sitting in flatland, as well as a triangle sitting next to her. The triangle spends five minutes walking in one direction and then at the five minute mark the triangle turns around and returns to where he started.
If you were to take a picture of Flatland at every instance and lay them on top of each other, you would see what is called a worm or a trail. Time in this case is moving perpendicular to Flatland (Geometry, Relativity, and the Fourth Dimension 57-58).

In the same way we can look at the three dimensional world as a series of worms moving perpendicular to the third dimension, in the direction of the fourth dimension. The universe as we see it at any moment is simply a three dimensional cross section of the four dimensional structure comprised of the four dimensional space time worms. However, if we are to believe this view of space-time as true, space-time as static, we also need to ask the question as to why we cannot see the past and the future. If this view is true, the past and the future exist in these space time worms, and therefore have been laid out for us. What then gives us the feeling that we are moving forward in time if we simply are passing through this unchanging space time worm, where the past and the future exist simultaneously? Our consciousness is moving forward in time, at least we think, but if that is true than shouldn’t each moment in our space time tube be illuminated if the future and the past both already exist? However, we do feel the passage of time, even if we exist in this static space time worm (Geometry, Relativity, and the Fourth Dimension 58-60).

If we still accept this view, that we are beings moving through these four dimensional space time worms, then we must answer the question of how we see time passing, even though we really exist at every moment through this space time worm. David Park, in his article “The Myth of the Passage of Time” hypothesized that we actually exist at each instant of our lives. He thinks that each moment of the past and the future exist permanently in this four
dimensional space time continuum. This illusion of time passing is a result of the fact that our memories of an event exist at a point that is before our current point. Every point on each individual’s “worm” is compared to other points by the memories that we have of our lives. And, according to this view, our former selves that we have memories of will always exist. At the current moment that you are reading this paper, the person that wrote this paper is still writing this paper, and will always be writing this paper. Each moment in our life will always exist, however according to our consciousness, the present always exists, and we will never know what the future is, and the past is gone. If the past existed, then we would be able to jump our consciousness back in time. However, since we are conscious at every moment of our lives, jumping back and forth in consciousness is not possible. Our consciousness at any given moment is not alterable. Even if it was possible to jump back in our consciousness to ten minutes ago or a year ago, we wouldn’t know that we had been in the “future.” All of the actions that we would perform from that moment on would be the same as those that we had already committed in the future (Geometry, Relativity, and the Fourth Dimension 60).

The concept of space time worms brings to the forefront the problem of free will. If we truly lived in a static space time, as discussed above, all of our future decisions will have been determined for us already making free will completely inconsequential. Many have a problem with this idea of a predetermined life, leading many physicists to consider other ideas so that different futures are an actual possibility rather than just having the future laid out for us. This leads us to the idea of a branching universe. Several physicists have proposed this idea in order to help sidestep the necessity of a predetermined world. Let’s consider a world where every
time someone had to make a choice, they chose between two things. This can be represented in a tree diagram of sorts.

(Geometry, Relativity, and the Fourth Dimension 64)

In order for these beings to fully have the freedom of choice, the being must have branches at any time they make a decision. All of the possible decisions and therefore possible futures must exist. A being may be under the illusion that it is experiencing only a single reality at any given time. However, there are actually infinite possible realities where the same being experiences every possible future at any given time. Therefore, under this view, every possible world should exist (Geometry, Relativity, and the Fourth Dimension 63). Under either view, however, time can be considered as our three dimensional world moving ana or kata, in the direction of the fourth dimension.

There have been many different ideas discussed regarding the fourth dimension, such as a spatial fourth dimension, our three dimensional space being curve around a four dimensional hypersphere, and time being a higher dimension and in some cases being compatible with this idea of a spatial fourth dimension. While scientists, physicists, mathematicians, and theologians alike have speculated as to whether or not a higher dimension is possible, and there have been
many attempts to find evidence of such ideas, in large part these attempts have proved
fruitless. There has never been any evidence gathered to prove any of these ideas. However,
there has also never been any evidence that has disproved any of these ideas. There are various
applications of the fourth dimension, should scientists ever be able to confirm and move
forward with these ideas of the fourth dimension. We may eventually be able to travel in time,
and the travel to parallel universes, but for now we are confined to our simple three
dimensional space.
Works Cited


