

# Chapter 2. Simulating Space and Time<sup>1</sup>

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*“To me every hour of the light and dark is a miracle,  
Every cubic inch of space is a miracle”*

Walt Whitman

## ABSTRACT

*This chapter asks if a virtual space-time could appear to those within it as our space-time does to us. A processing grid network is proposed to underlie not just matter and energy, but also space and time. The suggested "screen" for our familiar three dimensional world is the inner surface of a four-dimensional hyper-sphere bubble. Light waves and matter travel on this surface in directions defined by its architecture. Time derives from its processing sequences, as movies run static states together to emulate events. Yet what is proposed to exist is not the static states but the dynamic processing between them, with quantum collapse the irreversible event giving time its direction. In this virtual reality, empty space is null processing, directions are node connections, time is processing cycles, light is an information wave, objects are information tangles and energy is information in transfer. This strange interpretation suits a world where empty space is not empty, directions warp, time dilates, light never tires, existence smears and energy is the common currency of all interactions.*

## INTRODUCTION

The previous chapter proposed that since the virtual reality hypothesis is about the knowable world, its contrast with the objective reality hypothesis is testable, based simply on which better explains our world. This chapter develops a design to simulate a space-time like ours, while later chapters address light, matter and gravity, respectively

### Method

The virtual reality conjecture contradicts the positivist view that nothing exists outside the physical universe, but it doesn't contradict science. Only *assuming* it is impossible short circuits science, which should evaluate hypotheses not presume them wrong. That the physical world is a virtual reality seems absurd, but by thinking the unthinkable science has advanced in the past.

Driving this proposal is that objective reality assumptions no longer suffice to explain the findings of modern physics. In an objective reality time doesn't dilate, space doesn't bend, objects don't teleport and universes don't pop into existence from nowhere. No-one would doubt that the world was objective if only it would act so, but it doesn't. Terms like "spooky" and "weird" describe quantum and relativity theories, where common sense ideas of objects, time and space fail. There is something very odd about our world.

Science "proves" a hypothesis by assuming it so, *following the logic*, then testing it against world data<sup>2</sup>. So the way to test this theory is to do just that, to *assume* it is true, *design* a hypothetical model, then *validate* it against what the world actually does. If successful, the core laws of physics will derive in a sensible way from information theory, illustrating Tegmark's "*Physics from scratch*" approach [1] p6. The method is:

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<sup>1</sup> Available at <http://brianwhitworth.com/BW-VRT2.pdf>

<sup>2</sup> The virtual reality conjecture doesn't say the world isn't real, just that it isn't objectively real.

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1. *Specify*: List the requirements of a world like ours.
2. *Design*: Design a feasible model.
3. *Validate*: Is the model compatible with the physical world?
4. *Repeat*: Until design is impossible, logical inconsistency or validation failure.

The consistency constraint is significant, as an information design can easily emulate *one* requirement but to emulate many at once is not easy. The design should:

1. *Follow best practices*. Use established computer science principles.
2. *Satisfy Occam's razor*. Given a design choice, the simpler option should be taken.

The research questions proposed are:

1. *Could a virtual reality emulate the physical world as we see it?*
2. *Is the physical world more likely to be a virtual reality or an objective reality?*

While a virtual world's inhabitants can't see the programs creating it, they can see the virtual world itself. If that world is created by processing, then the nature of processing should manifest in it, e.g. it will consist of pixels that refresh at a finite rate. Simulated beings in a simulated world could look for the tell-tale signs of information processing. If we know how information behaves and how the world behaves, the physical world as a virtual reality is open to evaluation by anyone who cares to consider it.

## **History**

A hundred years of research have validated quantum and relativity theories in sub-atomic and cosmic domains, yet they conflict at the core. The quandary of physics today is that:

1. *Quantum theory* assumes an objective space background, which relativity specifically denies. For quantum theory to satisfy relativity it must be *background independent*, i.e. not assume, as it currently does, that quantum states arise in a fixed space and evolve in a fixed time [2].
2. *Relativity* assumes objects exist locally, which quantum theory specifically denies. For relativity to satisfy quantum theory it must be *foreground independent*, i.e. not assume, as it currently does, that there are localized objects moving through relative space-time.

These two great theories contradict because each debunks an objective reality assumption the other still clings to. Quantum theory challenges the objective reality of foreground objects, but still assumes a fixed background. Relativity theory challenges space and time as objective backgrounds, but still assumes fixed foreground objects. Both theories rebelled against the idea of objective reality in different ways, so each exposes the other's conceptual baggage but ignores its own.

To reconcile, both theories must abandon entirely all objective reality assumptions, i.e. reject objective space, objective time, objective existence, objective movement and any other ideas that imply independent substantiality. The prime axiom of the virtual reality conjecture is that nothing physical exists of or by itself. While the physical world seems substantial and self-sustaining, here *both foreground and background are dynamic information arising from processing*. There is no point in half-adopting a theory, so here is no fixed space or time for quantum states to exist in nor fixed objects to move relatively. There is only information processing, with space, time, matter and energy as incidental outputs. Not only are photons and electrons calculated by "space" [3], but space and time are also calculated, i.e. it is all information.

## **The grid**

A virtual reality that represents our reality needs *pixels*, *processing* and *programs* (Figure 1):

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1. *Pixels*. Whose information patterns are the "physical reality" of the virtual reality:
  - a. *Light*. Cyclical patterns passed between processing nodes.
  - b. *Matter*. Information pattern tangles that stay in a node.
  - c. *Energy*. The amount of processing in any transfer.
2. *Processing*. *The grid* is the processing screen that creates the pixels, where:
  - a. *Space*. The directions of space reflect grid transfer connections.
  - b. *Time*. The passage of time reflects grid processing cycles
3. *Programs*. If the grid screen shows the pixel patterns, the programs it runs must reside elsewhere. The next chapter attributes quantum collapse to this distinction.

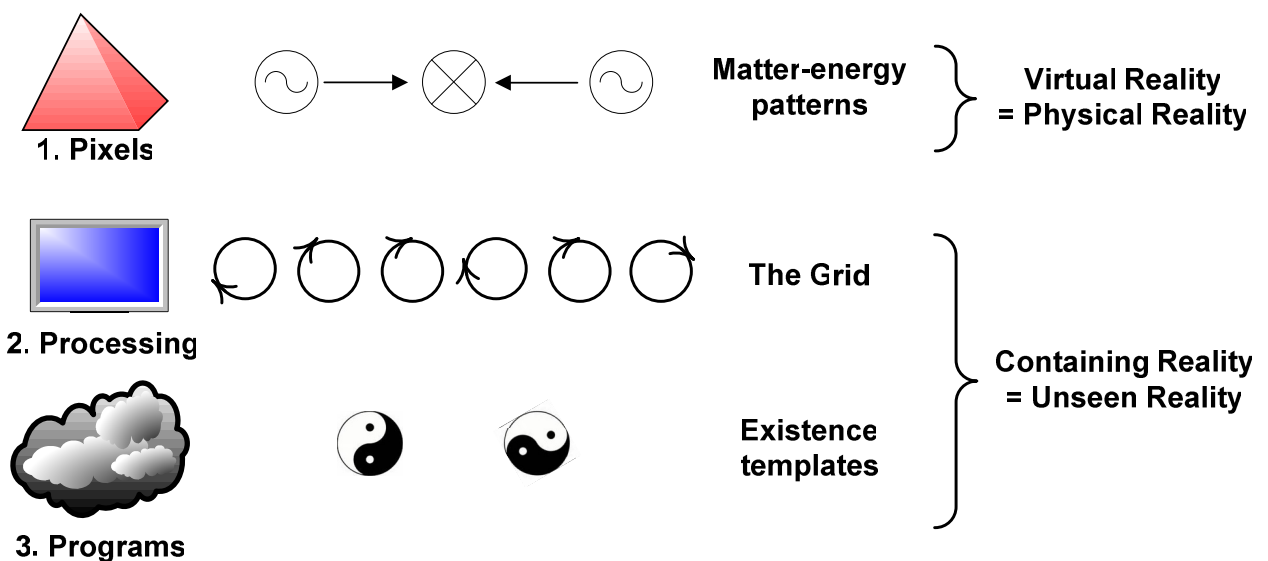


Figure 1. A virtual reality model

More details follow, but note that this is not new idea:

1. *Fredkin*. His solution "...only requires one far-fetched assumption: there is this place, *Other*, that hosts the engine that "runs" the physics." [4] p275.
2. *Wilczek*. Postulates "the Grid, that ur-stuff that underlies physical reality" [5] p111.
3. *Wheeler*. Coined the phrase "It from Bit", implying that at a deep level, all is information.
4. *D'Espagnat*. Suggests a "veiled reality" beyond time, space, matter and energy [6].
5. *Tegmark*. His External Reality Hypothesis that "There exists an external physical reality completely independent of us humans" allows the Mathematical Universe Hypothesis that: "Our external physical reality is a mathematical structure", which in turn allows the Computable Universe Hypothesis that: "The mathematical structure that is our external physical reality is defined by computable functions" [1].
4. *Campbell*. Proposes that "The big computer (TBC)" runs everything [7].
5. *Barbour*. Visualizes quantum waves as arising from an underlying landscape, where "The mists come and go, changing constantly over a landscape that itself never changes" [8] p230.

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The *processing grid* of Figure 1 could be Fredkin's "other", Wilczek's Grid and Wheeler's "bit" (processing) from which "it" (the physical world) is derived. It fits D'Espagnat's view of the physical world as a veiled reality, as when viewing a computer simulation the underlying screen is indeed "veiled" by the image upon it. The grid is also an external reality that computes the physical world, as Tegmark hypothesizes, it is Campbell's big computer, and Barbour's quantum mists could be processing patterns on a grid landscape.

As a city draws electricity from an power grid, so a virtual world could draw information patterns from a processing grid. *Reverse engineering the grid design* then raises questions like:

1. *Architecture*. How do the grid nodes connect?
2. *Processing* What algorithms do the nodes calculate?
3. *Protocol*. What are the information transfer rules?
4. *Synchronization*: How are transfers synchronized?
5. *Backup*. Are information copies kept?
6. *Recovery*: How does a node recover from an information overload?
7. *Movement*. How do the information patterns move?

This chapter considers the first four questions and later chapters address the others.

## **BASIC CONCEPTS**

### **Dynamic information**

What is information?

#### *Definition*

Shannon and Weaver began modern information theory by defining information as the logarithm to the base two<sup>3</sup> of the number of choices [9]. So a communication channel's bandwidth depends on the number of choices available, with two choices being one bit, 256 choices 8 bits or a byte, and one choice, which is no choice at all, is zero information. Information processing is then the transformation of information.

Now while a book is generally taken to contain information, its text is physically fixed the way it is. In itself the book exists as *one* physical choice, which by the above definition is *zero* information. At first this seems a false conclusion, but hieroglyphics that one can't decipher do indeed have zero information. A book only gives information if it can be read, when the reader's processing choices create information, e.g. the first symbol could be any alphabet letter, etc. A book's information *depends entirely on the receiver decoding process*.

So reading every 10th letter of a book, as in a code, gives both a different message and a different amount of information. Conversely, if the encoding process is unknown the information in the book is undefined, e.g. while the genetic alphabet is fully known the genetic code is not, as we are still learning how gene "words" enhance and suppress each other. To illustrate how information assumes decoding, consider a single electronic pulse sent down a wire. It can be one bit of information, but if it means ASCII value "1" it gives one byte of information, or if it means the first word in "Aardvark" a dictionary it gives many bytes, i.e. the information in a physical message is undefined if its encoding is unknown. Hence data compression can store the same information in a physically smaller signal, by using more efficient encoding. Only if a reader reverses the original encoding of the writer do reader and writer agree on the

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<sup>3</sup> Information  $I = \log_2(N)$  for  $N$  choices.

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information a message contains. In general, static information, as in a book, only exists in a dynamic processing context.

### *Static vs. dynamic information*

Let *static information* derive from an assumed decoding process while *dynamic information* arises by actually making choices. So writing a book creates dynamic information, as one could write it in many ways, as does reading a book, as it can be read in many ways, but a static book itself has no dynamic information, as it is just one way and no other. While static information can only exist in the context of a dynamic process, dynamic information is context free. It needs no external “reader” to exist.

Consider McCabe's argument that the physical world can't be virtual: if all digital simulations need an interpretive context to define what represents what, as noted above, and if these contexts derive from the physical world, then the physical world cannot also be the output of such a simulation [10]. The logic is correct for static information, which requires a viewer, but not for dynamic information, which does not. The physical world can't be a static information simulation, but it could be a dynamic one.

That static information can't underlie the universe is shown by imagining it “frozen” into a static state at a moment in time. It could then have static information, as a book does, but who would “read” it? Not us, as we would be frozen too. Without a reader, a frozen world has no information. Static information is “dead”, like the letters on this page without you the reader. Einstein discovered special relativity by imagining he was “surfing” a light wave “frozen” in space and time. He concluded that this was impossible, and so changed our ideas of space and time instead.

*In the virtual reality conjecture, the physical world is dynamic information that interprets itself.* Such a universe, built from dynamic information, can't exist without making choices. Like a TV screen image, it disappears if it is not continually refreshed. Luckily the laws of physics require change - by special relativity light can't freeze and all quantum entities in the universe quiver with quantum uncertainty. The definition of dynamic information implies a world that is in a continuous bubbling flux, which is exactly what we see. The only thing that never changes in our world is change itself.

If a virtual reality “leaks” dynamic information it will eventually run down. That it hasn't requires there to be the same number of dynamic choices after an interaction as before. Again a feature of our reality is its conservation of matter, charge, energy and momentum, to which quantum theory adds spin, isospin, quark flavor and color. Yet all these conservation laws are partial, e.g. matter is not conserved in nuclear reactions and quark flavor is not conserved in weak interactions. In this theory, one law of conservation rules them all: *that dynamic information is always conserved*<sup>4</sup>.

## **Reality pixels**

The definition of information as choice assumes a finite set to choose from. As finite choices can't give an infinite continuum, a digital world must be discrete. Continuously dividing a virtual space must give a minimum “pixel” which cannot be split, and continuously dividing a virtual time must give a minimum “tick” which cannot be paused. So does our reality work this way? If it is continuous it can't be virtual.

Investigations of the continuity of our world break down at the order of Planck length, much smaller than an atom, and Planck time, much shorter than a light cycle. To examine such short distances or times needs short wavelength light, which is high energy light, but putting too much energy into a small space gives a black hole, which screens information from us. If you probe the black hole with more energy it simply expands its horizon and reveals no more. So in particle physics no-one knows what occurs below the Planck length. Just as closely inspecting a TV screen reveals only dots and refresh cycles, so closely

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<sup>4</sup> Except for the initial event, but see the later section of this chapter.

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inspecting physical reality reveals only Planck limits. If the world is a screen, then physicists know its resolution and refresh rate<sup>5</sup>. These are limits no technology advances will ever breach.

The *continuum problem* has plagued physics since Zeno's paradoxes over two thousand years ago [11]:

1. If a tortoise running from a hare sequentially occupies infinite points of space, how can the hare catch it? Every time it gets to where the tortoise was, the tortoise has moved a little further on.
2. Or, if space-time is not infinitely divisible, there must be an instant when the arrow from a bow is in a fixed unmoving position. If so, how can many such instants beget movement?

The paradoxes remain today as infinities in physics equations that assume continuity, e.g. infinitely close charges should experience an infinite force, and light with zero mass should go infinitely fast<sup>6</sup>. Only a virtual universe of irreducible pixels and indivisible ticks makes these infinities disappear, like ghosts in the day, as that there is no infinitely small prevents the infinitely large from occurring.

It follows that continuity is a mathematical convenience rather than an empirical reality:

*"... although we habitually assume that there is a continuum of points of space and time this is just an assumption that is ... convenient ... There is no deep reason to believe that that space and time are continuous, rather than discrete..."* [12] p57

Computer simulations in loop quantum gravity [13] and cellular automata [14] assume space is a lattice of processing points and time their processing cycles, as is now done here also.

### **Life on a brane**

Some suggest the universe is a quantum computer embedded in space-time:

*"Imagine the quantum computation embedded in space and time. Each logic gate now sites at a point in space and time, and the wires represent physical paths along which the quantum bits flow from one point to another."* [15] p172.

However a virtual world cannot process itself [16], so the physical world can't be both the virtual reality output and the virtual reality processing: *one can't have one's virtual cake and eat it too*. The unavoidable logical "price" of the virtual reality conjecture is that there be a containing reality.

Virtual realities in our three-dimensional containing reality present on two-dimensional surfaces, e.g. computers, TV and movies work this way. The extra dimension is used to express the information on the screen. In general, the "surface" mediating a virtual reality must have at least one dimension less than its containing reality. It is not necessarily a flat surface, as is the case within our world. So our world as a virtual reality could be a three dimensional surface in a four dimensional bulk:

*"When it comes to the visible universe the situation could be subtle. The three-dimensional volume of space might be the surface area of a four dimensional volume"* [12] p180

In 1919 Kaluza found that writing Einstein's general relativity equations for four dimensions of space produced Maxwell's electro-magnetic equations automatically, uniting quantum theory and gravity. This breakthrough was ignored at the time, as in an objective four-dimensional space gravity would vary as an inverse cube not an inverse square, so our solar system for example would collapse. To explain how an objective world could have an extra dimension we can't see, Klein suggested it was curled up in a tiny circle, so entering it soon returned you to where you began. String theory uses six such "compactified"

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<sup>5</sup> Planck length of  $10^{-33}$  meter is the pixel resolution. Planck time gives  $10^{43}$  times per second as the refresh rate.

<sup>6</sup> By Newton  $F = m \cdot a$  where  $F$  is force,  $m$  is mass, and  $a$  is acceleration. Hence  $a = F/m$ , so a force acting on a mass of zero ( $m=0$ ) should give infinite acceleration.

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dimensions to model gravity. Yet why would an objective reality have six extra dimensions curled up inside it that it never uses in the first place?

In our *existence geocentrism*, any extra dimensions of physics must be contained within our world, but in the virtual reality conjecture our world is contained by an unseen dimension that surrounds us, i.e. the dimension is too large to see not too small to see. That we are on a *brane* of a higher-dimensional bulk is now a common idea in physics:

*“Physicists have now returned to the idea that the three-dimensional world that surrounds us could be a three-dimensional slice of a higher dimensional world.”* [17] p52

Randall and Sundrum’s local gravity model faithfully reproduces relativistic gravity using an extra dimension of infinite length, given that it is “sequestered” from our space [17]. If our space is a surface, and our existence transverse waves upon it, the dimension at right angles to space is indeed sequestered from us, as a transverse wave can’t leave the surface that it travels upon.

For example, water waves travel on a pool surface by vibrating its water molecules up and down. So the dimension at right angles to the pool surface must be free to move. If the pool top is sealed in concrete so it cannot vibrate, then no waves can travel on its surface. A wave on a surface needs a degree of freedom orthogonal to that surface, which for the pool is its up and down amplitude. By this argument, the direction of a wave’s amplitude vibration is not available to it as a direction of travel. In simple terms, a wave can never leave the surface it travels upon. So if we are quantum probability waves on a three-dimensional surface, the amplitude of those waves is *to us* an “imaginary” direction, into which we can never go. We can no more leave our space than an onscreen avatar can leave a computer screen.

If one abandons the assumption of the world as an objective reality, an extra dimension could wrap around our world rather than curl up within it. Our universe would then be a surface in a bulk of more dimensions, and all existence would be vibrations on that surface.

### **Distributed processing**

An objective space described by absolute Cartesian coordinates needs:

1. *A zero point origin:* It needs a fixed centre, i.e. a (0,0,0) point.
2. *A known size:* The maximum space size defines coordinate memory needed, e.g. the point (2,9,8) in a 9 unit cube space must be stored as (002,009,008) for a 999x999x999 cube space.

Yet the galaxies in our universe are all expanding equally away from each other, not from a centre, and are expanding to an as yet undefined maximum size. A Cartesian simulation would need an allocated size from the start, *i.e. before the big bang*, and exceeding this allocation would give a Y2K problem<sup>7</sup>.

Cartesian coordinates work for small spaces but *don’t scale well* for universes like ours that expand for billions of years. In scalable network design both the system load and the processing to handle it increase with size [18], e.g. the Internet is scalable, because new nodes<sup>8</sup> that increase network load also add more processing. As network supply rises in tandem with network demand, the system can grow indefinitely. Scalability also shares control, which is why the Internet has no “control centre”. While initially some saw this as a recipe for disaster, sharing control lets systems evolve better. And while an infinity anywhere in a centralized virtual universe could “crash” it, distributed systems localize any problems. If grid processing is distributed not centralized, then each node only has to work with its local neighbors:

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<sup>7</sup> Before 2000 older computers stored years as two digits to save memory, e.g. 1949 was stored as “49”. The year 2000 gave the “Y2K” problem, as the coordinates were all used up already. The year after 1999 was “00”, which had already been used (for 1900). A lot of money was spent fixing this problem.

<sup>8</sup> The nodes of the Internet network are Internet Service providers, or ISPs.

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“I remember ... Richard Feynman ... saying that he thought of a point in space-time as being like a computer with an input and output connecting neighboring points.” [19] p138

In the virtual reality conjecture, a point in space-time is processed by a grid node, but it is not a fixed mapping. As space expands, new nodes add both more space and more processing, so its “performance” doesn’t change as it expands - a desirable feature for an expanding universe. Distributed processing allocates each node a finite amount of processing to manage its locality. This predicts that a finite region of space has a finite maximum information capacity, as does the spin network theory of loop quantum gravity [20]. If black holes represent the maximum any grid node can process, that they expand when objects (information) fall into them suggests that in our world finite space has a finite processing capacity. As findings from cosmology suggest:

“...recent observations favor cosmological models in which there are fundamental upper bounds on both the information content and information processing rate.” [21] p13.

In a distributed network each node has a finite capacity, implying that a finite region of space can only handle a finite amount of matter, and black holes show that our reality has exactly this property.

## SPACE AS INFORMATION PROCESSING

### Does space exist?

Knowing when information patterns in a system "collide" is not a trivial issue. Two design options are:

1. *Objects calculate interactions.* Each entity calculates its collisions by comparing its position with all the others. In this case space arises from the objects in it, but for *each* entity in the universe to compare its position relative to *every* other at every moment is an enormous computing task.
2. *Space calculates interactions.* Each grid node processes a point of “space” *per cycle*, and objects collide if they request processing from the same node in the same cycle. Now calculating collisions is simpler, but space exists as something apart from the objects in it.

As computing favors the simpler option, which option does our reality favor?

Whether space exists apart from the objects within it has concerned the greatest minds of physics. Simply put: *if every object in the universe disappeared would space still be there?* Is space “something” or is it truly nothing? Newton saw space as an objective canvas upon which objects are painted, so it still existed even without objects. Leibniz found empty space as a substance with no properties unthinkable, so argued that space is just object relations. In a vast empty space there is no “where” for an object to be, and “distance” is only defined relative to other distances, e.g. a meter was the length between two marks on a platinum-iridium bar held in Paris. For Leibniz objects moved with respect to each other, not an imaginary “space”. So if the objects in the universe disappeared, there would be no space.

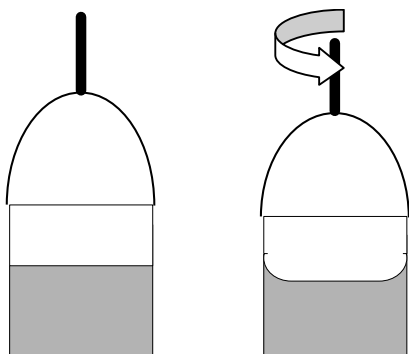


Figure 3. Newton's' bucket.

Newton's reply to Leibniz was Newton's bucket - imagine a bucket filled with water hanging from a rope that is spun around (Figure 3). First the bucket spins but not the water, but soon the water also spins and presses up against the side to make a concave surface. If the spinning water moves with respect to another object, what is it? It can't be the bucket, as at the start when the bucket spins relative to the water the surface is flat. Only later when bucket and water spin at the same speed is it concave. In an otherwise empty universe where all movement is relative, Newton's spinning bucket should be indistinguishable from one that is still. Or consider a spinning ice skater in a stadium whose arms splay outwards due to the spin. One *could* see

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this as relative movement, as the stadium spinning around the skater, but if so the skater's arms would not splay. This suggests that the skater *really is spinning* in space [22] p32.

This seemed to settle the matter until Einstein upset Newton's idea of an absolute space through which objects move. Mach then tried to resurrect relative movement by arguing that the water in Newton's bucket rotated with respect to all the matter of the universe. According to Mach, in a truly empty universe the surface of Newton's spinning bucket would remain flat and a spinning skater's arms would not splay outwards! This reflects how unsettling to object orientated physicists is the idea that space, which one cannot touch or measure, is:

“... *something substantial enough to provide the ultimate absolute benchmark for motion.*” [22] p37

Rather than the objects creating space by their relations, as Leibniz thought, the current verdict is that “*space-time is a something*” [22] p75. In the virtual reality conjecture, space, whether empty or full, is the processing of an unseen grid. Yet it isn't the sort of objective backdrop Newton envisaged, as which node links to which pixel is not fixed. So an "object" that moves with respect to the objects around it need not move with respect to the grid, e.g. an onscreen avatar walking through an onscreen forest can stay at the same point on a screen because neither the virtual foreground nor the virtual background are fixed with respect to the screen. Equally, a screen avatar could "see" other pixels by interacting with them, but not see the screen that creates all pixels.

### **The architecture of space**

It seems strange to talk of the "architecture" of space, but computer simulations of it do just that:

“...*we think of empty spacetime as some immaterial substance, consisting of a very large number of minute, structureless pieces, and if we let these ... interact with one another according to simple rules ... they will spontaneously arrange themselves into a whole that in many ways looks like the observed universe.*” [23] p25.

This raises the strange question *What does space do?* Here is a possible specification:

1. *Existence.* Space allows objects to exist within it.
2. *Dimensions.* Space offers three degrees of movement freedom.
3. *Interaction.* Space defines when entities interact.
4. *Direction.* Space naturally moves objects in apparent straight lines (geodesics).

Can a distributed grid satisfy these requirements, e.g. *derive* the directions of space from its architecture? The following derives the three dimension case from the one and two dimension cases.

#### *The Euclidean barrier*

Euclidean space is so deeply embedded in our minds that we tend to see it as the only way a space can be and structure all spaces accordingly, e.g. war-gamers divide their maps into hexagons that cover it completely, not octagons that don't. The ideal of regular lattice computer simulations is a *static structure* that maps nodes to points in an ideal Euclidean space [24]. However our space curves and bends, so it is an apparent Euclidean space not an actual one, and relativity can't be mapped by any static structure. To model our space as it is, not as we imagine it, needs a *dynamic structure*, that allocates nodes to spatial points as Internet protocols allocate dynamic IP addresses - on demand.

To limit that which creates space by the space it creates is backwards logic. We exist in space, but what creates space need not, e.g. an Internet computer that creates a web location isn't itself located on the web but in physical space. Its space is different, as cyber-space measures “distance” in clicks while in physical space it is measured in miles. While the following figures necessarily show grid nodes in our space, one shouldn't imagine they exist there. Which node goes “where” is irrelevant in this architecture, as "near" is

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a connection definition not an objective reality. "Distance" on a network depends solely on its structure, so terms like "close" and "straight" arise from the connections, e.g. a node connected directly to another is "near" to it, while one that is many intermediate nodes away is "far". The directions and distances of what we call space should derive from how the nodes connect, as it is only the connections matter.

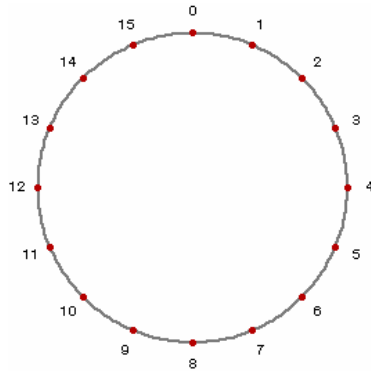


Figure 4. One-dimensional space

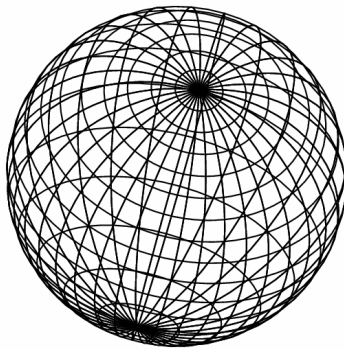


Figure 5. Two-dimensional space

### On demand connections

How the Figure 5 nodes connect depends on the rotation axis used. A node on the rotation axis of the original one-dimensional circle (Figure 4) will become a *pole*, with many longitudes radiating out from it, each linking to a neighbor node. These nodes form a *planar circle* around the pole, and their connections define how it transfers information, i.e. its direction choices on the sphere surface.

Yet the rotation making that node a pole was arbitrary. Rotating the original circle on a different axis gives the same sphere but a different connection configuration. The set of all possible rotations defines all possible connection configurations for the sphere surface. As all rotations involve the same nodes, changing the rotation axis only changes the node connections, which is easy for a network to do. Cell phone networks regularly change their architecture to improve efficiency under load. So *each node can locally configure itself as a pole*, simply by setting its connections so.

The coordinates of this space are defined on demand after a focal node is chosen, i.e. "just in time". There are no global coordinates for all grid nodes, as each node has its own longitudes and latitudes. Each node "paints" its own coordinates when activated, i.e. defines its own space. That this doesn't allow an

### A two dimensional space

In Wilson's original idea of a lattice creating space, each vertice is a volume of space. From this Penrose developed the spin networks used in loop quantum gravity, where each vertice joins three event lines, so two inputs can give one output [25].

In the structure proposed here, the vertices are processing nodes and the lines between them information transfer channels, but while each node is still a "volume" of space, it has many neighbors not just three.

If a set of processing nodes of equal capacity each connects itself to two arbitrary others, the result is a one dimensional space (Figure 4). Connecting one node to two neighbors gives two transfer directions, left and right. One notional rotation creates one dimension of space, as defined by the node connections.

To add another dimension, "rotate" the circle just created around an axis. Each node now forms another circle like the first, with the same number of points. This allows it two "orthogonal" movement dimensions, and the space can be visualized as a sphere surface with longitudes and latitudes (Figure 5). A two-dimension "flatlander" confined to points on the surface of this sphere would see a space that is:

1. *Finite*. It has finite number of points.
2. *Unbounded*. Moving in any direction never ends.
3. *With no centre*. Each point is a centre of the sphere surface.
4. *Approximately flat*. If the sphere is large enough.
5. *Simply connected*. Any loop on it can shrink to a point.

## Simulating space and time

objective view from without doesn't matter, as this simulation is only ever seen from within, and dynamic information doesn't need an external observer. This apparent bug turns out to be a feature when relativity is considered.

As the connection requirements are symmetric, *every* node connects to a planar circle of neighbors around it, defining different directions out into the space. These directions, which are the node's transfer links, are veridical to an ideal sphere surface, i.e. correctly approximate it. So a two dimensional space can be modeled symmetrically by two consecutive rotations, up to any granularity, if each node locally defines its own connections *as if it were the original node origin of the rotations that created the space*.

The *network granularity* of the above space depends on the number of discrete steps in the rotations that create it. While a perfect circle has an infinite number of rotation steps, a discrete circle has only a

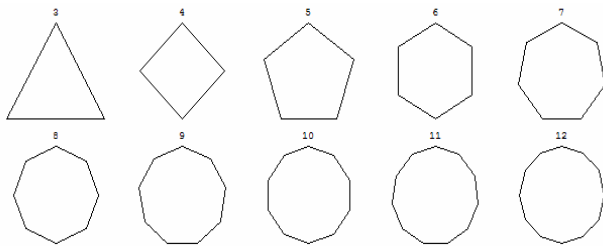


Figure 6. Discrete circles,  $N = 3-12$

finite number. In this view, all polygons are discrete circles, e.g. a triangle is a “3-circle”, a square is a “4-circle”, a pentagon a “5-circle”, and so on (Figure 6). So every polygon is an  $N$ -circle that increasingly approximates an ideal circle as  $N$  increases. Conversely, any discrete circle can decompose into triangles, so any discrete circle simulation can also be modeled by triangle-based simulations like spin networks.

Most space simulations use triangles to simplify the mathematics, but allowing only three movement directions is unrealistic. War gamers prefer hexagons to squares as they give six movement directions not four, but avoid octagons as they don't fully fill the board. What changes with granularity is the number of directions the space allows. Dropping the need for an objective Euclidean space, this model proposes a discrete circle of many sides to give many directions.

Discrete circles with more points increase network granularity and improve its approximation of continuous space, but even with the finest granularity, one can never fully cover a flat space with circles. Nor are all connections reversible, so retracing a route taken back again need not return one to the same start node, though it will be a true vicinity. Essentially, this space has “holes” in it, so point objects, as electrons are thought to be, could pass right through each other. This would be a problem for the model if quantum entities existed at exact locations, but luckily in our world they don't. They exist probabilistically over an area, as smears not points, and so don't need exact locations to interact. Objects will register as returning to the same point if they return to the correct vicinity. *That quantum objects exist inexactly avoids the problems of an inexact non-Euclidean space.*

### Space as a hyper-surface

The mathematician Riemann first wondered if our space was the three-dimensional surface of a *hyper-sphere*. He asked, if a mathematical hyper-surface is a three dimensional space, how can we say for sure that our space is not so? Are we, like Mr. A. Square of Flatland [26], unable to imagine a dimension beyond those we experience? If rotating a circle into a sphere generates two dimensions from one, rotating a sphere must, by the same logic, give three dimensions from two. We can't imagine “rotating” a sphere, but mathematically it is well defined. The result is a *hyper-sphere*, whose *hyper-surface* is an unbounded, simply connected three-dimensional space with no centre, as our space is.

In this model the architecture of space arises from rotation upon rotation, all symmetrical, but is still discrete. This space has no edges, like ours, and expands equally across its extent, again as our space does. It has no “edge” because it is unbounded, like the surface of a sphere.

## Simulating space and time

The granularity of the grid, the number of connections per node, limits the number of directions in the space. If each node has a fixed number of connections, there must be a minimum *Planck event angle* for single node quantum events<sup>9</sup>, i.e. direction, like length, is predicted to be quantized.

The space proposed must also be curved, so if our space is perfectly flat it can't be a hyper-surface.

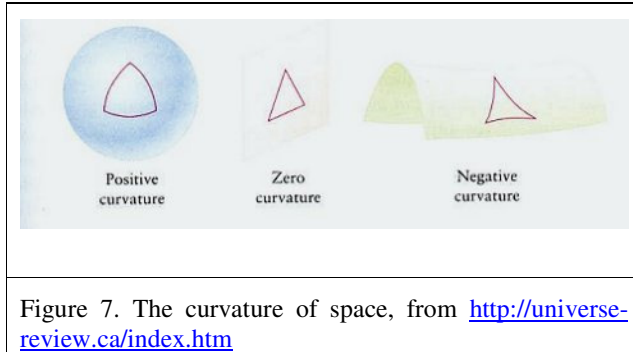


Figure 7. The curvature of space, from <http://universe-review.ca/index.htm>

Fortunately in general relativity space can be locally curved by gravity. That space curves at all *requires* a dimension for it to curve into. A three-dimensional space cannot curve without a fourth spatial dimension to curve into. If space can curve locally, cosmologists wondered if it is curved globally? One test is how a triangle's angles add up. In flat space they add up to 180°, with *positive curvature* they are more than 180°, and with *negative curvature* they are less (Figure 7). So the angles of a triangle laid out on the earth add up to more than 180°, as the earth's surface is positively

curved. Of course for thousands of years we didn't detect that, so likewise the curvature of a universe that has expanded at the speed of light for billions of years may no longer be discernible. It is as near to flat as we can measure, but that is just the universe we see.

### Virtual existence

Imagine a pond with waves moving across its surface. The water molecules themselves don't travel - they just vibrate up and down. Only the wave *pattern*, which is information, travels. Our "solid" world could arise at the quantum level in the same way - as moving information wave patterns. If space is a hyper-surface of a four-dimensional sphere, it can vibrate in an extra dimension in and out from its centre, like bumps and dimples on a ball. Transverse waves could then travel its three-dimensional surface as water waves travel a pond surface - by vibrating at right angles to it.

If the electrons, quarks and photons of our world are wave forms orthogonal to space, how can we ever detect them? We can if we exist as they do. If *all* existence is vibrations orthogonal to space, the world could interact as waves on a surface interact. "Observation" is then basically the interference of waves.

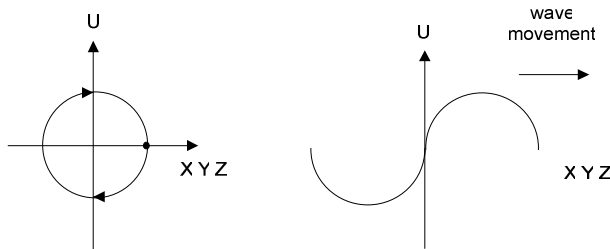


Figure 8. Processing a. Space and b. Light

The basic vibration could be a stationary circular function turning into an *unseen dimension*, shown as U in Figure 8a. This function could represent empty space, as it has zero net surface displacement, is simple to calculate, gives a null result and is continuously calculable. In later chapters this function "on the move" is light (Figure 8b) and matter is a multi-dimensional tangle of high energy light.

So in the virtual reality conjecture, all matter derives from oscillations into an unseen dimension beyond space. In Schrödinger's equation, the core of quantum mechanics, matter is a three-dimensional wave whose value at any point is "something" the mathematic doesn't define, except to say its value is in an imaginary complex dimension. Schrödinger called it a "matter density" wave, because high values mean that matter is more likely to be there. Born

<sup>9</sup> If a node has N neighbors in a circle around it, the minimum Planck event angle is  $360^\circ/N$ .

## Simulating space and time

called it a probability wave as its amplitude squared is the probability the entity exists at that point. One would expect the ultimate formula of an objective reality to represent something physical, but it doesn't. It is in itself just information, a number that doesn't derive from mass, momentum, velocity or any other physical property, yet the physical properties of the world derive from it. A physical world that emerges from quantum probabilities is consistent with the idea that *substantial matter arises from insubstantial information*.

### A transfer algorithm

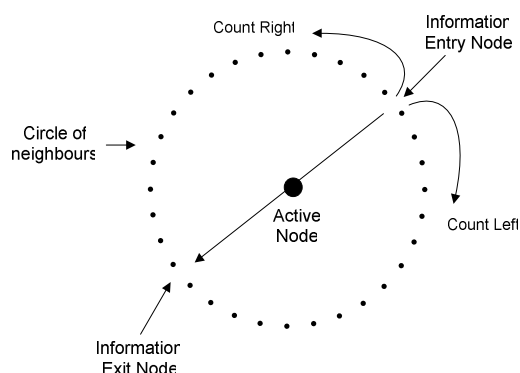
In our world an unforced object travels in a straight line, defined as the shortest distance between two points. The general term is a *geodesic*, e.g. on a curved surface like the earth the shortest distances between points are longitudes and latitudes, which are geodesics even though they are curved. Geodesics are the lines along which objects naturally move. They define space, so changing them changes space, e.g. gravity “curves space” by changing the geodesics. A “point” in space is defined by the geodesics passing through it at an instant of time:

“A point in spacetime is then represented by the set of light rays that passes through it.” [27] p110

In this model, the directions of space arise from how grid nodes connect, as each node is surrounded by others that *approximate* the directions around it. How grid nodes receive and pass on entity calculations defines the constant passage-ways of space we call straight lines or geodesics. A transfer algorithm to define how grid nodes transfer information is now proposed, first for two dimensions then for three.

#### Two dimensions

In Figure 5, every node on the two dimensional surface made itself a “pole” by its connections to a local *planar circle* of neighbors. It now needs a transfer algorithm to tell it which neighbor to pass information packets received on to, i.e. to specify an “out” node given an “in” node:



For any planar circle entry node, what exit node produces straight line routes?

If each node transfers input to the *opposite* neighbor of the planar circle, as shown in Figure 9, a set of such transfers uses the fewest nodes for a route, which is a straight line. Maximally separating entry and exit nodes on the planar circle minimizes the route. A node can easily find the “opposite” node to any planar circle entry node by counting opposite ways from the entry point until an overlap occurs. This simple rule then gives straight lines in a two dimensional space.

Figure 9. Planar circle entry/exit nodes.

#### Three dimensions

In three dimensions each node has a sphere of neighbors, not a circle, but suppose *all transfers in three dimensional space still occur in planar circles*. That quantum transfers occur in two-dimensions is not unthinkable, as quantum Hall models use two-dimensional excitations called *anyons* to derive quantum events [28]. If planar circles are the basic transfer channel, photons are always polarized in a plane because they are always transmitted that way.

If all transfers occur in planar circles, the three-dimensional problem reduces to keeping transmissions in the same plane. As one can cut sphere into many planes, so a node has many planar circles around it. On receiving a packet, it must decide which one to use. This, as before, is essentially an in/out problem:

## Simulating space and time

Given the sending node's planar circle, which planar circle of the receiving node should process it?

Again a simple rule is available, namely to use the one that overlaps nodes with the sending planar circle. That only one planar circle satisfies this derives from the connection architecture, but can be seen spatially as that two neighbor circles in the same plane always overlap three points (Figure 10). So the receiving node can process an incoming packet using the planar circle triggered by nodes of the sender planar circle. A chain of planar circles that link together form a straight line channel of movement (Figure 10).

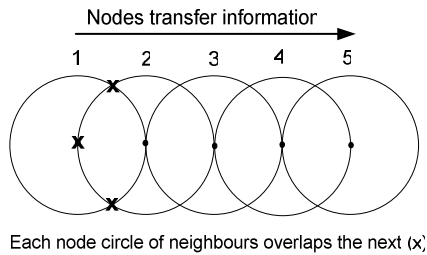


Figure 10. Planar circle overlap.

orthogonal to all space, from the Figure 9 *planar circles*, which are polarization planes in our space. Both are discrete circles arising from the grid, but the first processes existence while the second processes space.

### Summary

A grid architecture that connects overlapping planar circles, plus a transfer algorithm that maximally separates entry/exit nodes, can simulate straight lines. The processing load differential of gravity will later be argued to bend light by skewing this transfer algorithm.

Distinguish the Figure 8 *transverse circles*, which are

## TIME AS INFORMATION PROCESSING

Does an extra existence dimension plus four dimensions of space-time give five dimensions in all? The simpler idea explored here is that the dimensions of time and existence are one and the same. This model has only four degrees of freedom, three for space and one for existence and time. It supports the Hartle-Hawkin no-boundary theory, that the big bang began with *four dimensions of space*, one of which "somehow" became the dimension of time [29]. That "somehow" is here proposed to be by becoming the dimension of existence processing, which here equates to what we call time.

### Virtual time

Objective time should pass inevitably by its own nature, not depending on anything else, while virtual time always depends on the processing behind the virtual reality, e.g. in John Conway's "Life" simulation (Figure 11) pixels reproduce and die by program rules, so blobs grow and contract until (often) a steady state is reached<sup>10</sup>. For a pixel entity within the Life simulation, time is measured by the events that occur to it, i.e. many events constitute (for it) a long time, while a few events are a short time. We measure time like this in our world, as atomic clocks effectively count atomic events.

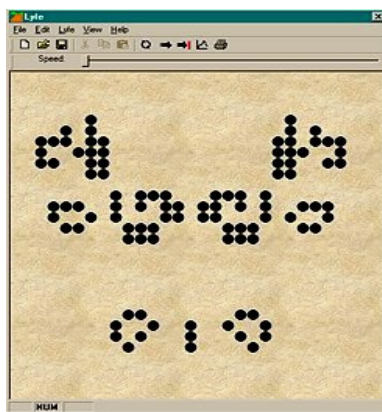


Figure 11. The Life simulation

Suppose a Life game that usually takes twenty minutes to reach a certain state is run again on a faster computer and reaches the same state in only two seconds. Running the game again took a less time in our reality, but the passage of time within the virtual reality did not change, as the same number of events occurred. A pixel avatar in the simulation who sees the same number of events pass will conclude the same amount of time has passed. The

<sup>10</sup> See <http://abc.net.au/science/holo/lablife.htm> for an example.

## *Simulating space and time*

passage of time in a virtual reality doesn't depend on the passage of time in its containing reality. *Virtual time depends solely on the number of processing cycles that occur in the virtual reality.*

If a computer screen slows down due to processing load, an external observer sees it slow down, but an onscreen avatar sees no difference, as they themselves also slow down. So if our world is a virtual reality, we can't in principle see load effects, and indeed relativistic changes in space-time are undetectable to the parties affected. However if the screen processing is distributed, as proposed here, those affected can compare notes, to see that time rate differences really did occur.

For example in Einstein's twin paradox, a twin travels the universe in a rocket that accelerates to near the speed of light, and returns a year later to find his brother an old man of eighty. Neither twin was aware their time ran differently, and neither was cheated as both get their allocated number of life breaths. Yet one twin's life is nearly over while the other's is just beginning. Particle accelerator experiments show unequivocally that time really does slow with speed, so the twin paradox is not fantasy.

In the virtual reality conjecture, grid nodes under a speed processing load process events slower. As the rocket twin's rapid movement loaded the grid, it could only process one year's worth of events for him. He cannot know his time is dilated, but just sees a normal year of events pass by. In contrast, the grid processing his twin on earth has no such load, so can run faster. Eighty years of his life events cycle by in the usual way. Only when the two re-unite is it apparent that their time ran at different rates. Only in a virtual reality, where time is processing, can such time dilation occur.

### **A time like ours**

The specification for a time like ours might be:

1. *Sequentiality.* Time creates a sequence of events.
2. *Causality.* Time allows one event to cause another.
3. *Unpredictability.* Time sequences are unpredictable.
4. *Irreversibility.* Time can't go backwards, except for anti-matter.

We know a sequence of states can represent time, as movies are sequences of static pictures run together to seem life-like. A fine enough sequence can represent any degree of reality. In the virtual reality conjecture, time passing actually is a finite sequence, as in Zeno's idea of movement as a sequence of indivisible instants in space. Perhaps the calculus of Leibniz and Newton works so well because things really do vary in infinitesimals of space and time. Using infinitesimals to predict changes in the world makes sense if the world really does work that way. One could replace all the delta time values in the equations of physics with delta-sequence values<sup>11</sup>.

If nodes "tick" over processing cycles, then *no event can occur in less than a grid node cycle.* Time is essentially the number of cycles a grid node completes. This clarifies Einstein's view that for light, time itself stands still. If light travels at one node per tick, then it moves to the next node before a node event can occur. If light never experiences a node cycle, then time never passes for it, i.e. its time stops.

### **States or events?**

Barbour suggests that a state sequence can constitute a timeless "time capsule", whose states theoretically exist simultaneously, like the pages of a book [8] p31. Yet as argued earlier, a static states only contain information when dynamically processed by an external reader. So who could read a timeless

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<sup>11</sup> Replace each  $dt$  or  $dx$  term in calculus with a  $ds$  term, a small extent in a finite sequence of states. Now as  $ds$ , the number of intervening states, "tends to zero" it becomes zero when there are no more intervening states.

## *Simulating space and time*

capsule of past, present and future? Certainly not us, who are pictures on its pages. In dynamic processing no static states can exist timelessly.

Between the assumed static states of a time sequence are choices, which by the definition of information imply a “before” and an “after”. Before a choice there are many options, but after there is only the chosen one. So the idea of causality derives from the idea of choosing, as in quantum mechanics a state can:

“... evolve to a finite number of possible successor states” [30] p1.

A choice *causes* its successor states if other choices would give different outcomes. Without choice there is just an inevitable sequence, where nothing can be said to “cause” anything else.

Equally, before a choice occurs it is by definition unknown. A choice already known is no choice at all, i.e. zero information. So time as information processing choices denies a fixed future set in place. Perhaps one can foretell likely futures by tapping into present trends or wishes, but if making choices creates time, the future is not a road laid out in advance.

So rather the time being a sequence of static states, which would need a decoding context, it could be a sequence of dynamic choices, which are context free. In an objective reality, static states are “things that exist” in and of themselves, but in a virtual reality, dynamic choices only allow “*The Physics of Now*”:

“*Past, present, and future are not properties of four-dimensional spacetime but notions describing how individual IGUSs {information gathering and utilizing systems} process information.*” [31] p101

If time is a sequence of choices, not a sequence of states, then it is indeed processing.

To hold that all the events of our universe are stored in a permanent record of static states strikes two problems. First, the states that arise from a universe of interactions are innumerable. Indeed, even simulations in our world find that trying to store a static database of its past soon creates excessive storage demands. A database of every *quantum event* in the history of the universe is not only unthinkable but pointless, as viewing this “record” would be like getting to know someone by reading the three billion letters of their DNA.

Or if one only records what is important, how is “important” decided? This is an equally intractable problem, especially in our world, where by the butterfly effect of chaos theory, a single photon could change human history<sup>12</sup>.

The dynamic model proposed here has no static storage at all. Yet a dynamic present can still record the past, e.g. our brains recall the past. What exists now *is* a record of the past, e.g. the “memory” of fossil rocks tells us today what occurred on earth long ago. Our DNA reflects not just our ancestors but the entire human race, if not all life on earth. The perfect solution to what to save is that the database that stores the past is the present. In this “evolutionary storage system”, genes [32], memes [33] and norms [34] persist for thousands or millions of years by their generative power, while that which exists solely for itself fades away. The world decides what the record keeps by its ongoing choices of what lives on. A dynamic, causal virtual reality that stores nothing in static form can itself be a summary all that has been.

Dynamic processing can never create states that are static or permanent of themselves. It may appear so, but each view of a so-called static state is just the making of another choice. In a world of dynamic processing there is no objective fixed world, only the choices of an *ever-present here and eternal now*.

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<sup>12</sup> The human eye can detect a single photon, and one person can change the world, so a photon could change the world. If so, every photon is potentially “important”.

## *Simulating space and time*

### **Time travel**

A choice sequence can only be run backwards if all the choices in it are reversible. If a sequence contains an irreversible choice, that can't be undone, then the sequence also becomes itself irreversible. In quantum physics the collapse of the wave function, which occurs whenever quantum entities interact or restructure, is a one-way, random change that cannot be reversed. So any sequence of quantum events that includes a quantum interaction is irreversible, given that every wave function collapse is a random choice.

Yet time, as proposed, is the processing of a circle of values. So a single entity could, *in between interactions*, reverse its processing sequence, as a rotation isn't irreversible. A later paper proposes that all normal matter involves clockwise processing, while anti-clockwise processing creates anti-matter. That all matter processes the same way is not unreasonable, as consistency in time direction is a necessary condition for a stable space in recent computer simulations of it [23]. Just joining nodes anyhow gave unpredictable results, sometimes a two-dimensional sheet and sometimes a crumpled vortex of infinite dimensions. Only when linked nodes had a common time direction did a stable space emerge, i.e. when all nodes processed in the same direction.

That Feynman diagrams show anti-matter particles entering events going backwards in time suggests that anti-matter runs our "time" in reverse, i.e. it runs the processing that creates our existence in reverse. Time going backwards doesn't mean anti-matter can undo its interactions, any more than matter can, just that it exists by processing a sequence opposite to ours. Anti-matter goes backwards in our time not its time, so an anti-matter entity would see our time as running backwards. Time as circular processing clarifies what it means to say that anti-matter runs time backwards.

Can one run a choice sequence forward to prophesize a predestined future? Einstein's argument that there is no agreed universal time is not an argument that any time is possible. That grid nodes can cycle at different rates allows time to go slower or faster, but this doesn't affect the *processing sequence*. Causality and unpredictability are preserved, as the following paradoxes show:

1. In the *grandfather paradox* a man travels back in time to kill his grandfather, so he could not be borne, so he could not kill him. One can have causality or travel back in time but not both.
2. In the *marmite paradox* I see forward in time that I will have marmite on toast for breakfast, but then choose not to, so didn't rightly see forward in time. One can have choice or predictability but not both.

If time as a processing is causal and unpredictable, these properties do not allow time travel.

### **Summary**

Time as an objective flow along which things inevitably move isn't how it happens in our world, though superficially it seems so. Time as event processing that slows with load fits the facts of modern physics better. Space as an objective backdrop to fixed objects isn't how it is in our world either, though again superficially it seems so. Space directions as node transfers again better explain how they "curve" under the load of large nearby masses. Rather than space and time existing objectively in and of themselves, both are more likely to be the by-products of grid information processing:

*"... many of today's leading physicists suspect that space and time, although pervasive, may not be truly fundamental."* [22] p471.

Objective space and time are convenient concepts that well explain the ordinary world we see, but poorly explain the extraordinary world of modern physics. Even today, when people first hear Einstein's theory that time and space are malleable, they suspect some sort of intellectual trick. Yet is no trick. It is not our *perceptions* of time or space that change but *actual time and space* as measured by instruments. What could possibly explain this, other than that our time and space are indeed virtual?

## OTHER IMPLICATIONS

That space and time are virtual has other implications for physics.

### The big bubble

Astronomers observe that all the stars and galaxies are receding away from us, so either we just happen to be the centre of the universe (again), or the view is the same from all vantage points. Yet how can space

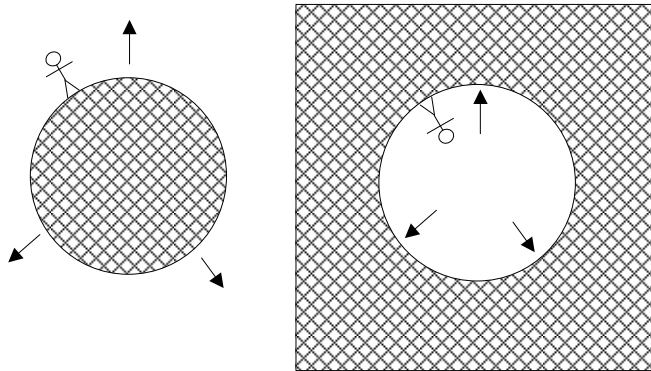


Figure 12a. The Big Bang, 12b. The Big Bubble

have its centre everywhere? According to cosmology, the big bang created our space and it has been expanding ever since, but how can space "expand"? Today, cosmic background radiation left over from the big bang is still everywhere, visible as static on blank TV screens. If the big bang exploded from a point singularity in objective space, the initial energy should be at the outskirts of the universe by now. So why is it still all around us? In contrast, if our space is not objective, how is it structured? The idea of an objective space that is "just there" poorly explains the cosmology of the big bang.

Space as a hyper-sphere surface fits the facts better, as like the surface of a sphere it is unbounded with no centre or edges. Travel in any direction, as on the earth, eventually returns one to the same vicinity. It can expand equally at every point, and a hyper-sphere surface explosion would first go "out" then wrap around the sphere to end up everywhere. In this view, cosmic back-ground radiation is still here because it has circled, perhaps many times, a universe that is a surface in a hyper-reality.

The term "Big Bang" assumes we are on the *outside* of a spherical expansion (Figure 12a) but it makes more sense if we are *inside* an expanding bubble (Figure 12b). Space as the inner surface of a hyper-bubble then answers other puzzling questions:

1. *What is the big bang expanding into?* It is expanding into a surrounding four dimensional bulk.
2. *What parts of space are expanding?* All parts equally. The expansion is throughout the universe, as new grid nodes fill the "gaps" that arise everywhere.
3. *As the universe expands, where does new space come from?* New space comes from the bulk the bubble is expanding into.
4. *If space is still expanding, are we expanding too?* No, existing matter doesn't expand. Only space expands, which makes old light into cold light by lengthening its wavelength.
5. *Was the entire universe once at a point singularity?* Not if it began as a hyper-sphere bubble, which is a unit sphere not a unit point, and not if it wasn't all created at once (see next).
6. *Why didn't the new universe immediately form a black hole?* A big crunch contracting the current universe would soon form a massive black hole. So why didn't the big bang immediately do the same? The next section suggests this is because the universe didn't come into being all at once.

### The initial event

Suppose the initial event was a single node that somehow split itself apart to "move" on the grid around it, as a dynamic information wave. Splitting an element of the bulk would leave a "hole", whose inner hyper-surface is the space of this model. The maximum frequency electro-magnetic wave created by the split would vibrate this surface as the first light. No black hole would occur, as the initial split creates

## Simulating space and time

more space than light - the processing of one node can't overload all those around it. In the virtual reality conjecture, the big bang was when *the grid divided to create light moving on the hyper-surface of space*.

The initial “tear” in the bulk could spread, like a rip in a stretched fabric. The resulting cataclysmic chain reaction would respect no speed of light limit, as it occurs at the node transfer rate not its cycle rate. Indeed, extrapolating the universe's expansion backwards shows it must have initially expanded faster than the speed of light, a period of exponential growth called inflation. In this model inflation is *the grid itself ripping apart*.

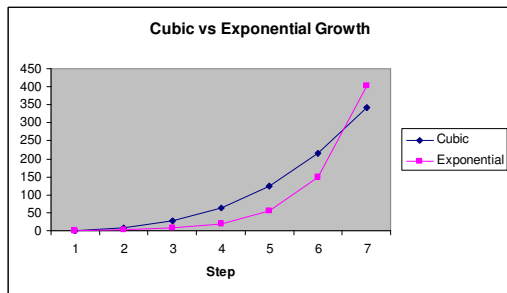


Figure 13. Cubic vs. exponential growth.

What then could stop inflation? If each node splits into two photons that create further splits, and also expands the hyper-surface of space, which growth predominates? If the chain reaction predominates inflation won't stop, but if space grows faster it will, as expanding space dilutes a wave moving on its surface by inserting new points into its wavelength. Hence cosmic background radiation, white hot at the dawn of time, is now cold.

The contrast is a three-dimensional space increasing as a cubic function vs. an exponential chain reaction. As Figure 13 shows, an independent cubic growth initially exceeds an exponential growth but is quickly overpowered. However in this model the cubic growth interacts with the chain reaction to slow it down, so could prevail. Even so, the resolution will be quick, and indeed by some cosmology estimates inflation was over in the first millionth of a second or less. In this model the bubble's expansion weakened the waves on its surface until the chain reaction stopped. The grid injury healed itself, but the hyper-bubble it created continued to expand at light speed.

If *all* the free information in the universe today arose from a once only inflation chain reaction, then it will be constant, as that event will not repeat [29]. In this view, the universe we see arose when part of the grid divided itself in the initial event. Since then, galaxies have formed and space has expanded, but never again has the grid itself ripped apart, so no more free information has been created. This avoids the ridiculous idea of a "real" universe that so meticulously conserves itself coming into existence entirely from "nothing", as big bang theory implies. It predicts that the total information of the universe is, and since inflation always has been, constant, and that no energy-matter interaction ever changes it.

So to the principle of dynamic information conservation, given earlier, must be added: "except during inflation". This suggests an even deeper conservation, that as matter can convert to energy because both are information, so the grid can convert to information because both are the grid, the same quintessence. What then is really conserved is the grid, whether as the message of light or the unseen medium that delivers it.

### The transfer synchrony problem

How an information network synchronizes information transfers is always a problem, e.g. if a node sends two “pass photon” events but the receiving node only completes one “receive photon” event, the second photon disappears. Dynamic information has no inherent reality, so what isn't passed doesn't exist. When computer simulations “lose” transfers, virtual world objects vanish for no apparent reason - forever. We have two solutions to this problem:

1. *Centralization*. Synchronize transfers by central control.
2. *Buffers*. Give each node memory storage to allow asynchrony.

## Simulating space and time

### Centralization

A computer's central processing unit (CPU) chip illustrates the transfer synchrony problem. If a CPU sends a command to retrieve data from memory into a register, how does it know *when* it has arrived in the register? As a CPU cycles billions of times a second, it must wait many cycles for anything else on the motherboard to happen. If it acts too soon it gets garbage left over from the last call, but if it waits too long it wastes its own processing cycles. Why not check if the register data has arrived? This is another command, which needs another register for the results, which then also needs checking!

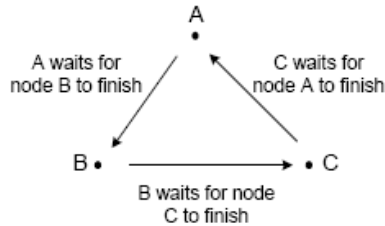


Figure 14. Transfer deadlock.

A virtual universe run this way would be as slow as its most overloaded node, which loses the gains of distributed processing.

### Buffers

Early networks that used centralized control systems like polling were reliable but slow. Modern network protocols, like Ethernet, are much more efficient because they let nodes act democratically, without autocratic central control. On distributed networks, like the Internet, each node runs at its own pace, and if it is busy when another node transmits to it, the input just goes into its buffer memory.

In computing, a buffer is memory that lets a fast device connect to a slow device without being slowed, e.g. when a computer (fast device) sends a document to a printer (slow device), the printer buffer accepts it, letting you continue working while the document prints. Likewise if an Internet node is busy it stores the transmission in a buffer, until it can process it.

Success with buffers depends on choosing their size and location correctly. If buffers are too big they waste memory for no value, while if buffers overflow the system can crash due to transfer “deadlock”, where A waits for B which is waiting for C which is waiting for A (Figure 14). If the network supporting our universe worked this way, part of space could become like a screen dead spot, unusable forever. And unlike the Internet, where known backbone servers can be allocated bigger buffers, where galaxies will be in space is unknown. An unpredictable, dynamic network cannot be run using fixed, static buffers.

### Pass it forward

If centralization is unsuited for distributed networks and buffers unsuited for dynamic networks, how can a dynamic distributed grid handle the transfer synchrony problem? If a node transfer *waits* for the destination node to finish what it is currently doing, the speed of light could vary for equivalent routes, which it never does. The alternative is that transfers *never wait*, i.e. are always handled immediately. So a node finishing an information packet immediately forwards it to the next node, which receives it.

In this model, a photon is dynamic information calculating itself through space from one grid node to the next. If sender and receiver nodes are synchronous, there is just a transfer, but what if they are not? If a node finishes processing a photon earlier than usual for some reason the *pass-it-forward protocol* sends it immediately to the next node, as if it didn't, it would be lost forever.

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However what if the receiving node is still processing another packet of dynamic information? How can it immediately receive an incoming information packet but still conserve the one it is currently processing? It can if it also passes its packet on to the next node, which if it hasn't finished its current cycle can do the same, and so on. The pass-it-forward ripple stops when a transfer synchrony occurs, but that can't be relied upon. It is also stopped by a null processing node, accepts the processing without passing anything on. This can be relied upon, as if space is expanding null nodes are always being added to it. An infinite pass it forward loop that runs forever around the bubble surface is impossible if the bubble is expanding.

With a pass-it-forward protocol nothing on the grid ever waits, so light transfer rates depend only on the local cycle rate. Light always moves forward at one node per local tick. This protocol needs no undefined allocation of static buffers, and as every processing packet is always passed on and accepted, no dynamic information is ever lost. The possibility of infinite pass-it-on loops is avoided by the expansion of space. The protocol also momentarily synchronizes sender and receiver nodes, so the light that fills space helps to synchronize the grid.

### **Empty space is full**

In an objective reality empty space should be empty, with zero energy, but in quantum theory:

*"... space, which has so much energy, is full rather than empty."* [35] p242.

In this view, empty space is the processing power of a black hole that just happens to be running a null cycle. The null cycle sets equal positive and negative values, which are "in" and "out" relative to the hyper-sphere surface (Figure 8a). If this processing power is distributed equally across the grid, every node, whether running empty space, some matter or a black hole, has the same processing capacity. As an "idle" computer still actively runs a null cycle, deciding billions of times a second to do nothing, so the apparently empty points of space also run their null cycle (Figure 8a). It is because the grid never stops processing that empty space is not empty [36]. Consider the evidence:

1. *Virtual particles.* In quantum theory *virtual particles and anti-particles* arise from space itself. They borrow energy from the vacuum, exist briefly, then disappear equally quickly back into it. They explain the *Casimir effect*, where two flat plates in a vacuum when placed close together experience a force pushing them inwards. This "pressure" is attributed to virtual particles in the vacuum around the plates pushing in. The same particles cant arise between the plates to push them back apart when they are closer than the virtual particle wavelength. Null processing could produce equal virtual matter and anti-matter particles, as equal cycles of opposite rotation equate to a null cycle.
2. *Vacuum energy.* What physicists call the energy of the vacuum arises in quantum theory because a point can't have a fixed energy, so can't have exactly zero energy. A null cycle of equal positive and negative values likewise *averages* zero, but isn't constantly at a zero value.
3. *The medium of light.* How can light, which is something that physically exists, vibrate a vacuum that is "nothing"? If space itself is the medium of something, then it cannot itself be nothing. A vacuum that transmits no physical world messages may seem "nothing" to us, but as the potential to transmit remains, it cannot actually be nothing. However if space is the null processing of an unseen grid, then it can mediate light as a screen mediates pixels. Empty space may be "empty" like a screen that mediates no pixels but is still switched on.
4. *New ether.* The idea of an ether that is physical like the objects it contains was shown false by the Michelson–Morley experiment, but the idea of a non-physical ether has never been contradicted:

*"Since 1905 when Einstein first did away with the luminiferous aether, the idea that space is filled with invisible substances has waged a vigorous comeback."* [22] p76

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The traditional argument against an ether is that a thin, transparent jelly-like substance permeating all space would give a standard frame of reference to all movement, which by Einstein doesn't exist. However a non-physical ether, such as the grid, is compatible both with quantum theory:

*"The ether, the mythical substance that nineteenth-century scientists believed filled the void, is a reality, according to quantum field theory" [37] p370.*

And with relativity:

*"According to the general theory of relativity space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of ... space and time..." [38]*

If the physical universe is a virtual reality, the new ether is the grid-screen that processes it.

### *A perfect transmitter*

When we view empty space we see nothing, just emptiness. This could mean nothing is there, as objective reality supposes, or that it is a processing host that perfectly transmits all light and matter, as proposed here. When one looks out a perfectly transparent window, the glass transmits the light from objects behind it. One sees the message of light the window passes, but not the glass medium that sends it. One only knows a glass window is there by its imperfections, by its frame surround, or by touching it.

Now imagine a world filled by a perfect transmitter with no imperfections so it can't be seen, that is all around so it has no boundary, and that transmits matter so it doesn't repel touch. If physics is information, then this is not impossible. If this medium filled every direction, one couldn't see around it. If it passed on all light perfectly, it would itself be unseen. And if we moved into it, it would just pass on the matter of our bodies on as it does light. Yet it could be known by logical inference, as is done here.

In the virtual reality conjecture, the grid is like a perfect diamond that completely fills the universe, continuously and flawlessly reflecting the images within it. Empty space then is quite "full", and the idea of "nothing" is just a figment of the human imagination.

## **CONCLUSIONS**

Over a century ago relativity and quantum theory, the precursors of physics today, left the safe haven of traditional reality to wander a conceptual wilderness of existence waves, quantum uncertainty, higher dimensions and malleable space-time. Their journey has revealed amazing mathematical tools, but today fundamental physics wanders in an intuitive desert filled only with mathematical thorns. The advance of string theory, parched of empirical data, is a theory everything that is turning into a theory of nothing [3]. As going back is not an option, its speculations go far but not far enough. As the journey of physics confronts the conceptual mountain of objective reality, let us recall the duck principle:

*If it looks like a duck, and quacks like a duck, then it is a duck.*

Our world, as modern physics paints it, looks remarkably like a virtual world:

1. *Quantum randomness* is independent of the physical world, so perhaps is from outside it.
2. *Complex rotations* explain light, so perhaps light does rotate in an imaginary dimension.
3. *Kaluza's* extra dimension unites relativity and Maxwell's equations, so perhaps it exists.
4. *Quantum waves* are probabilities, so perhaps the universe they produce is too.
5. *Planck limits* on space and time suggest a discrete world, so perhaps it is.
6. *Calculus* assumes infinitesimals can approximate reality, so perhaps they can.
7. *The uncertainty principle* denies fixed objective properties, so perhaps there aren't any.
8. *In Feynman's* sum over histories quantum particles travel every path, so perhaps they do.

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- 9. *Special relativity* lets time dilate, so perhaps it is just processing slowing down.
- 10. *General relativity* lets space bend, so perhaps it is a grid transfer algorithm warping under load.
- 11. *Cosmic background radiation* is still here, so perhaps the universe is on a hyper-sphere surface.

Is it unreasonable to believe what the equations of physics say? We use them freely to get results, so why reject what they imply? If our world acts like a virtual reality, in what scientific scripture is it written that it cannot possibly be one? The reader can decide for themselves if our space or time are virtual (Table 1), but would it really be so bad if they were? An information based reality is still real in its own terms, not a hallucination or an imagination. *It is just a local reality instead of an objective reality.* We have only our existential hubris to lose.

All that changes under this theory is that instead of *things* we have *choices*. It is a world where one can have but not hold, use but not keep, and act but not stay. If the information flux never stops, there is no fixed Utopian “end state”. Indeed there are no "states" at all, as if each *now* inevitably refreshes the choices, only the journey exists. Some might find this disheartening but I do not. Indeed it seems to me the world is pretty much like this already, as coffins have no pockets. One can’t possess a choice, one can only make it, but that surely is the greater gift.

*Table 1. Virtual properties and physical outcomes for space and time*

<b>Virtual Property</b>	<b>Physical Outcome</b>
<i>Dynamic reality.</i> A dynamic virtual reality: a) Continuously makes choices b) Conserves dynamic information	<i>World flux.</i> The physical world: a) Is always and everywhere a changing flux b) Has many partial conservation laws
<i>Pixels.</i> In a virtual reality: a) Nothing is continuous b) Space arises from discrete grid nodes c) Time arises from discrete processing cycles d) Direction arises from discrete connections	<i>Quantization.</i> In our world: a) Continuity creates paradoxes and infinities b) Space is quantized at Planck length c) Time is quantized at Planck time d) Direction is quantized? (Planck angle)
<i>Null processing.</i> Null processing: a) Produces no output b) Is continuously processing c) Equates to equal and opposite cycles d) Can host other processing	<i>Empty space.</i> Empty space: a) Looks like it is nothing b) Manifests vacuum energy c) Spawns virtual particles d) Is the medium of light and matter
<i>Distributed processing.</i> Allows: a) A system to scale up well b) Each node to paint its own connections c) Each node to cycle at its own rate d) A finite processing capacity for each node	<i>Localization.</i> Local space is consistent: a) The laws of physics are universal b) Each point has its own space (relativity) c) Each point has its own time (relativity) d) Finite space can only hold finite information
<i>Screen.</i> An expanding hyper-sphere surface: a) Has three dimensions b) Has no centre or edge c) Spreads objects on it equally apart d) An explosion on it ends up everywhere e) Keeps vibrations on its surface	<i>Space.</i> Our expanding space: a) Has three dimensions b) Has no centre or edge c) Is moving all the galaxies equally apart d) Cosmic background radiation is everywhere e) Limits entities to move within it
<i>Channels.</i> Grid transfers:	<i>Directions.</i> Objects naturally move in:

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a) Can simulate straight lines (geodesics) b) Can change with load differentials	a) Straight lines (geodesics) b) Geodesics are affected by gravity
<i>Time is processing.</i> Virtual time: a) Is measured by processing events b) Slows down with processing load c) Is a discrete sequence of choices d) Is one-way if a choice is irreversible e) Can run in reverse for an isolated entity	<i>Time is relative.</i> Our time: a) Is measured by atomic events b) Dilates for high speed or by a large mass c) Is simulated by movie state sequences d) Quantum collapse is an irreversible choice e) Anti-matter runs time in reverse
<i>The big bubble.</i> The initial "bubble": a) One node split gives a sphere not a point b) The chain reaction splits other nodes c) Creating the free information of the universe d) Bubble expansion dilutes the waves on it	<i>The big bang.</i> The initial "bang": a) Didn't give a massive black hole b) The initial inflation was faster than light c) The universe's information seems constant d) Cosmic background radiation is now cold

### DISCUSSION QUESTIONS

The following discussion questions highlight some of the issues covered. As no-one really knows, there are no absolute right or wrong answers. The aim is just to stimulate discussion:

1. If the physical world is a virtual reality, what is the image and what is the screen?
2. If the physical world is an image, what is its resolution and refresh rate?
3. Why can't the ongoing flux of our world ever stop?
4. Could an extra dimension wrap around our space?
5. Is space something or nothing?
6. Would a network simulating our universe be better centralized or distributed?
7. How is a hyper-sphere surface like our space?
8. If movement is a grid transfer, what are "straight lines" in network terms?
9. If our time is virtual, can we ever know if it slows down?
10. If time is a sequence of choices, can we roll the sequence back or forward?
11. Under what conditions can time flow backwards?
12. If space is expanding, what is it expanding into?
13. Why didn't the big bang immediately form a black hole?
14. Why is cosmic background radiation from the initial event still all around us?
15. If the total information in the universe is constant, how did it arise in the first place?
16. How can a distributed network solve the transfer synchrony problem without buffers?
17. If empty space is full, what is it full of?

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### **History**

Cornell University censors deleted an earlier version of this paper submitted to ArXiv, saying:

*"Your submission has been removed upon a notice from our moderators, who determined it inappropriate for arXiv. Please send to a conventional journal instead for the requisite feedback."*

A request for valid reasons was promised but never provided, so a truer statement would be:

*"Although you are a recognized academic professional, our anonymous staff have censored your work for undisclosed reasons. Since we aren't accountable, don't bother asking why as we won't reply."*

The once free Los Alamos archive has become another autocratic academic castle [39].