

# Exploring the virtual reality conjecture

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## Introduction

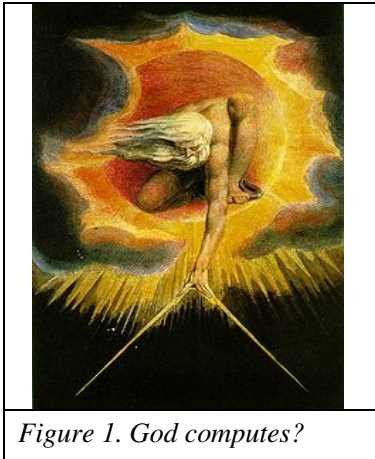


Figure 1. God computes?

Computers today simulate entire worlds, with their own time, space and objects, but that our world could be so is normally a topic of science fiction, not physics. Yet that the world is illusory has a long history. In Buddhism, the world expresses the Universal Mind, in Hinduism it is Maya, the illusion of "God's play", and to Plato it was just shadows flickering on a wall<sup>1</sup>. That the world is digital is also not new, as to Pythagoras numbers were the non-material essence of the world, Plato felt that "God geometrizes" and Gauss that "God computes", as in Blake's "Ancient of Days" (Figure 1). The tradition continues today, as Zuse argues that "space calculates" [1] and others ask if reality computes?<sup>2</sup> This essay explores the *virtual reality (VR) conjecture*, that the physical world is the digital output of quantum processing.

One can contrast Platonic *idealism*, that the seen world reflects a greater unseen one, with Aristotelian *physicalism*, that what we see is all there is. Logically, one of these world views must be wrong, but after centuries of dispute, science and religion formed the truce of *dualism*, that mind and body realms *both* exist, dividing scientists into atheists who saw *only* the physical world, theists who *also* believed in a non-physical reality and agnostics who didn't know.

Today, dualism seems increasingly a union of opposites, a marriage of convenience not truth. If different mind and body realms exist but don't interact, what relevance are they to each other? Or if they do interact, which came first? If a conscious mind "emerges" from a physical brain, isn't it superfluous? Or if the mind creates the body as in a dream, why can't I dream the body I want? Dualism is currently in retreat before the simpler, non-dual view *that there is only one real world*. Scientists observing this ideological war generally feel that if there is only one world, let it be the one we study.

If everything is physical and so is quantum computing,<sup>3</sup> could a self-contained universe compute itself, i.e. *entirely* output itself? An objective physical universe can no more do this<sup>4</sup> than a physical computer can print itself out<sup>5</sup> [3 p6], but a virtual physical universe could arise from external processing. Yet then it is not complete in itself, i.e. the VR conjecture contradicts the "prime axiom" of physics, that:

*There is nothing outside the physical universe* [7].

Indeed, it implies its antithesis, that:

*There is nothing inside the physical universe that exists objectively, i.e. of or by itself.*

Given the options:

- Physicalism*. Only the physical world exists.
- Solipsism*<sup>6</sup>. It is all just a mind illusion.
- Dualism*. Another reality exists beyond the physical.

Logically, another non-dual option remains, namely *virtualism* [6], that only the "other" reality exists. In this admittedly radical view, the "ghostly" world of quantum theory is the real world and our physical world is just an image on a screen thrown up.

This doesn't, as some naively think, imply "hardware" in a metaphysical realm. The quantum world is quite unlike the physical world we know: quantum states can disappear at any time so are not

permanent like matter. Entangled entities ignore speed of light limits on physical movement and superposed states exist simultaneously in physically contradictory ways. The quantum world is in every way *physically impossible*, so physicality cannot be the nature of its reality.

That *this* world is an objective reality or a virtual reality are mutually exclusive hypotheses about it. If science finds that it *cannot* be objectively real, it must explore if it is virtual.

## The evidence

We know how simulations operate, so how does our world measure up?

*Ten reasons to suspect that the physical world is a simulation*

1. *The big bang.* That our universe arose from “nothing” in an initial time zero event makes no sense for an objective reality, but every virtual reality boots up from nothing in itself.
2. *The speed of light.* An objective reality has no reason for a maximum speed, but every simulation screen has a maximum refresh rate that limits local transfers.
3. *Planck limits.* An objective space has no reason to be discrete, as our world seems to be at the Planck level, but a virtual space must be so.
4. *Non-locality.* Effects that *instantly* affect entities *anywhere* in the universe, like entanglement and quantum collapse, are impossible in an objective reality, but a program can alter pixels anywhere on a screen, even on one as big as our universe.
5. *Malleable space-time.* Mass and movement should not alter time or space in an objective reality, but a massive body could use up local processing to dilate time and curve space.
6. *Randomness.* If every physical event is predicted by others, a random quantum event is an impossible “uncaused cause”, but a processor creating a virtual world can be its cause.
7. *Empty space is not empty.* In an objective reality empty space is “nothing at all”, but space as null processing can spawn the virtual particles of the Casimir effect.
8. *Superposition.* Objective entities cannot spin in two directions at once as quantum entities do, but a program can divide itself to do this<sup>7</sup>.
9. *Equivalence.* That every electron in our world is *exactly* like every other<sup>8</sup> is untenable for an objective world, but simulations typically use entity templates.
10. *Quantum tunnelling.* An electron “tunnelling” through an impenetrable field barrier, like a coin popping out of a perfectly sealed glass bottle, is impossible if objects continuously exist, but not if they are discrete event frames.

Each of the above is fundamentally *impossible* for an objective reality but not for a virtual one. The evidence is that our world behaves like a simulation, so by the duck principle:

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

Do we then live in the Matrix? In that movie, people knew their reality by the information it gave them, as we know ours. When a pill disconnects the hero from his input, he falls back into the real world, where physical machines are farming people's brains in vats. The VR conjecture is the *opposite idea*, that the physical world is only the simulation, not what creates it.

Nor is this *solipsism*, that the physical world is just a dream, which Dr Johnson is said to have refuted by stubbing his toe on a stone, saying “*I disprove it thus*”. The VR conjecture is again the *opposite idea*, that a quantum reality is “out there” apart from us - it just has no physical properties.

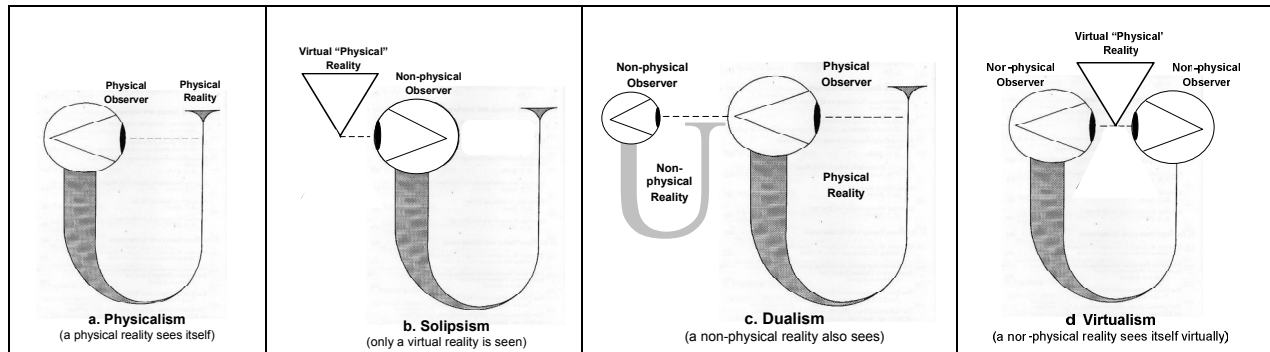


Figure 2. Universal (U) models

Figure 2 shows the options. In *physicalism* (2a), a self-existent physicality sees itself when consciousness mystically "emerges" from it [9]. In *solipsism* (2b), a self-existent consciousness imagines a dream world that doesn't really exist at all. In *dualism* (2c), a self-existent physical world has a self-existent higher reality observing it. In *virtualism* (2d), a self-existent but non-physical reality experiences itself using a virtual reality that, like a game reality, has no inherent existence. The result is a *local reality*, that is internally real but externally unreal, i.e. stubbing virtual toes still hurts.

In the VR conjecture, the physical substrate is virtual but the *observer substrate* is not, so it can underlie consciousness<sup>9</sup>. This is no unreal dream universe, with us its existential centre, because *everything* is "knowing" everything else<sup>10</sup>, like the most massive of online multiplayer games. How a system can simulate itself to itself is subtle<sup>11</sup>, but is essentially that there is indeed a real world around us - it just isn't the world we see.

## The model

In computing, information depends on the finite number of discrete choice options<sup>12</sup> [10], and *processing* transforms information, i.e. makes a new choice. This model aims to *reverse engineer* the physical world, i.e. derive time, space, energy, light and matter from processing.

### The processing grid

A simulated world needs a network to produce it, which Wilczek calls:

"the Grid, that *ur-stuff* that underlies physical reality" [11 p111].

This grid can be envisioned as a logical network whose nodes dynamically connect, like a cell-phone grid, but passing instructions not static data. So a photon is a *program* telling grid nodes to set quantum state *pixels*, whose instructions pass between nodes as *packets*. Each node runs the packets it receives by the computing method of "instantiation"<sup>13</sup> then shares its processing with *all* its neighbours, so quantum waves spread like ripples on a 3D pond. All light, energy and matter are postulated to arise from grid activity, with black holes being the grid at full capacity.

As each node has a finite capacity, packets from different programs can overload it<sup>14</sup>, i.e. "collide". A photon arrives at a detector screen as a "cloud" of distributed program packets<sup>15</sup>. Each packet then requests processing from nodes already busy processing the matter of the screen. When those nodes overload, they reboot, i.e. try to re-read all their processing from scratch. The first *single* grid node to acquire the *entire* photon program is the point where it "hits" the screen<sup>16</sup>.



Figure 3. A simulation

The grid restart node is random<sup>17</sup> to us, as it depends on which node the program services first. The restart allocates all the photon's instructions to one node cycle, so all other packets instantly "disappear", i.e. quantum collapse is just the inevitable disbanding of packets when their program source reforms [8].

The model also accommodates relativity, as if the avatars of Figure 3 are just pixels then so is their background. *No fixed node-pixel mapping is needed*, as one can "move" an avatar through a forest by bit-shifting image pixels across the forest or by bit-shifting the forest pixels behind the image. An avatar can stay centre-screen yet "move" through a forest that is scrolling behind it, i.e. have

a constant relativistic "frame-of-reference"<sup>18</sup>.

The grid proposed is not space, time, energy or matter, *but what creates them*. Empty space is just the grid on "idle", like a screen that is blank but still "on". Turning it off, to show the screen (grid) itself, would also destroy the images on it (us). If quantum programs create the physical world, can we "hack" into them? Quantum computing is doing just that already.

When looking out a window one can see the glass only by its flaws, by the frame around it, or by touching it. If the grid is a flawless transmitter all around us it has no frame, and if it transmits matter one can't touch it. It can be deduced, as here, but not seen directly. If quantum mechanics is the camera taking the "photos" we call physical reality, it can no more appear in the pictures it creates than a finger can point to itself.

#### Time as processing

While objective time passes inevitably by its own nature, virtual time passes by processing choices, e.g. in Conway's "Life" (Figure 4) pixels live and die by program events. A game that ran in twenty minutes on one computer could run in two seconds on a faster one, but an avatar in both games would see the same virtual time pass, as the same number of game events occurred. We measure our time this way, as atomic clocks count atomic events. In the twin paradox a twin on a rocket accelerating to near the speed of light returns a year later to find his brother an old man of eighty, i.e. his time slowed down. In this model, his movement used up grid processing, leaving less to process his life's events, compared to his twin on earth.

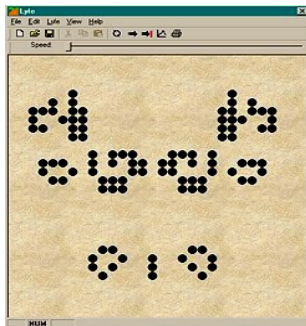


Figure 4. Life<sup>19</sup>

particle accelerator experiments time really does slow down. It is not *perceptions* of time that change but *actual time*, as measured by instruments. Only in a virtual reality, where time is the *local* number of processing events, can this be.

So time stops entirely for light because before a node can "tick" a processing cycle, the photon moves on. When people hear that time slows down they suspect an intellectual trick, but it is no trick. In

#### Space as processing

Continuously dividing a virtual time gives a "tick" which cannot be paused and continuously dividing a virtual space gives a "pixel" which cannot be split. In our world, studying Planck length or time needs short wavelength light, which is high energy light, but putting too much energy into a small space gives a black hole, which hides information from us. Probing a black hole with more energy just increases its size, to reveal no more. As closely inspecting a TV screen reveals only dots and refresh cycles, so closely inspecting our world reveals its resolution and refresh rate<sup>20</sup>. A digital universe of irreducible pixels and indivisible ticks resolves the *continuum problem* that has plagued physics since Zeno first

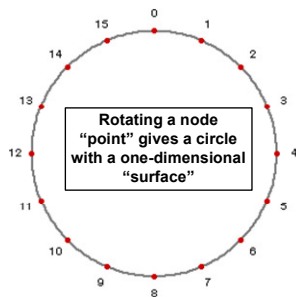


Figure 5. One-dimension

outlined his paradoxes<sup>21</sup>.

Loop quantum gravity, cellular automata and lattice simulations [12] map nodes to points in a *static* Euclidean space, but relativity needs nodes allocated to points *dynamically*, as the Internet allocates IP addresses - on demand.

A finite set of "mini-CPU" nodes can form a dimension by arbitrarily linking up into a circle, so each node can transmit in left and right "directions" (Figure 5).

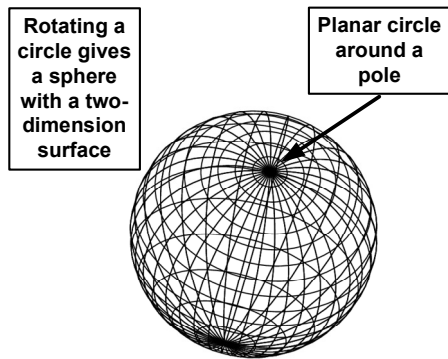


Figure 6. Two-dimensions

Repeating the notional rotation, gives a discrete sphere with a two-dimensional surface (Figure 6). A *pole* of this sphere has a *planar circle* of nodes around it to define its "directions". Yet the rotation axis making that node a pole was arbitrary. Choosing a different axis lets another node be a "pole" on the same sphere surface. Networks can easily alter links, so let *each node locally configure itself as a pole*, by setting its local links so. Now by rotational symmetry, *every node has a planar circle of neighbours veridical to directions on an ideal sphere with itself the rotation origin*. Each node can "paint" its own longitudes and latitudes when activated, i.e. define its own space.

Figure 7 just repeats the above<sup>22</sup>. As rotating a circle gives a sphere so rotating a sphere gives a *hyper-sphere*, whose *surface* is unbounded, simply connected and three-dimensional - just like our space<sup>23</sup>. Its *granularity* is the number of discrete steps in the N-rotation creating it, where a triangle is a "3-circle", a square a "4-circle", etc. Yet with N large, discrete circles cannot tessellate a surface, i.e. this space has "holes" in it. Point entities like electrons could pass right through each other, but in our world quantum entities exist over an area, so are at the "same point" if in the same vicinity. *That quantum entities exist inexactly lets an inexact, non-Euclidean space simulate ours*.

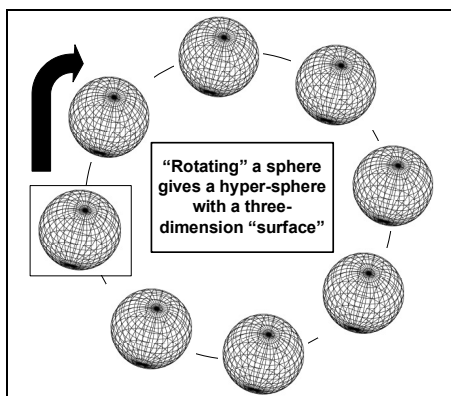


Figure 7. Three-dimensions

A node on a three dimensional hyper-surface has a sphere of neighbours, but that *all grid transfers use planar circles* is not unthinkable, as quantum Hall models use two-dimensional *anyon* excitations to derive quantum events [14]. In this model, one node has many planar transfer channels, where a photon polarized in a plane uses one channel. If discrete planar circles define directions, there should be a minimum *Planck angle* for

single node quantum events [5]<sup>24</sup>.

## Implications

### The big bubble?

An objective universe that "just is" may transform its parts but not its total *steady state*. So last century, big bang theory battled it out with respected physicists, for whom a steady state physical universe just "popping up" out of nowhere was highly unlikely. Yet that all the galaxies are expanding out from us at a known rate implies a source event about 14 billion years ago. Finding cosmic background radiation left over from the big bang has confirmed it for most physicists today.

The failure of steady state theory removes a cornerstone of support for the idea of an objective universe that exists in and of itself. Physics today "defines away" questions like "*What existed before the big bang?*" as irrelevant, but any universe that *began* is dependent, so what it depends on is a valid question. Could a time and space that suddenly appeared, for no apparent reason, equally suddenly disappear today? If nothing in the universe comes from nothing, how can an entire universe do so? That an objective physical universe *arose from nothing* is not just incredible, it is inconceivable.

In contrast, this model *requires* a big bang. Every virtual reality begins with an information influx that starts *its* space and time. Any computer booting up starts a “big bang”, before which there was indeed "nothing" (in computer memory). Here, the big bang was just when our universe booted up.

The term “Big Bang” puts us *outside* an expanding sphere (Figure 8a) but maybe we are inside a bubble, or hyper-bubble, expanding into a bulk around it (Figure 8b)<sup>25</sup>. Space as a hyper-bubble surface is unbounded but finite, and expands but has no centre, just like our space. Its expansion isn't evident as it doesn't alter existing matter - the bulk just fills the "gaps" that arise everywhere. An explosion on such a surface will first go “out” then wrap around to end up everywhere. So cosmic back-ground radiation is still all around us, not at the edge of an objective universe, because it has circled the universe many times.

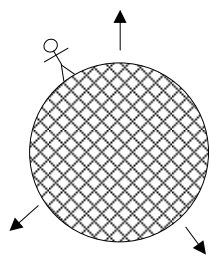
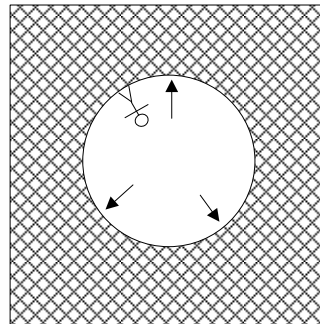


Figure 8a. A bang



8b. A bubble

### Light as processing

Does an extra dimension plus four dimensions of space-time give five dimensions in all? In this model the dimensions of time and existence are one and the same. It has four degrees of freedom, three for space and one for *existence in time*. It fits the Hartle-Hawkin no-boundary theory that initially one of four equivalent dimensions "somehow" became time while the other three formed space [15]. Here, that somehow was as the

dimension into which quantum wave-entities oscillate to exist. Indeed, without such an extra *space-like* dimension, how can our space "curve", as relativity says it does? If light waves move *on* space, as water waves move on a pond surface, they cannot leave it. We register them only because we exist in the same way as they do<sup>26</sup>.

That a photon exists as a "thing in itself" poorly explains its behaviour as a wave vibrating in a medium. Without a physical “ether”, physicists must just *declare* that light vibrates "nothing"<sup>27</sup>. Yet vibrating nothing to create something makes no sense.

Light is said to be a “... *self-renewing field disturbance*.” [11 p212], begging the question of what renews the fields that renew? That an electric force powers a magnetic force that powers an electric force, etc., is like Peter paying Paul’s bill and Paul paying Peter’s bill, etc. Were this possible, I could borrow a million dollars today and never pay it back<sup>28</sup>.

Do light waves oscillate in space, as sound waves do in air? An objective realist might say how else could it be? Yet while empty space has no sound, it still transmits light, or we couldn’t see the stars at night. So how can vibrating nothing have a physical direction? And as space can’t distinguish direction, with "up" from one view being "down" from another<sup>29</sup>, how can a spatial oscillation give the positive-negative valences of electromagnetism? The idea that light is a *frictionless wave vibrating nothing in a spatial direction* is quite implausible.

In contrast, light as *processing wave* in an ever-active grid processing medium can "oscillate" frictionless information values. The plus-minus values of electro-magnetism are then the in-out values of a logical hyper-surface, like bumps and dimples on a ball. The constant speed of light in a vacuum is the surface idle rate, as every screen has a refresh rate, making the real speed of light just one (transfer per node cycle). Light then slows down in glass because the matter of the glass uses up local processing. We *say* the medium of light is space or glass, but here its medium is *always* the grid<sup>30</sup>.

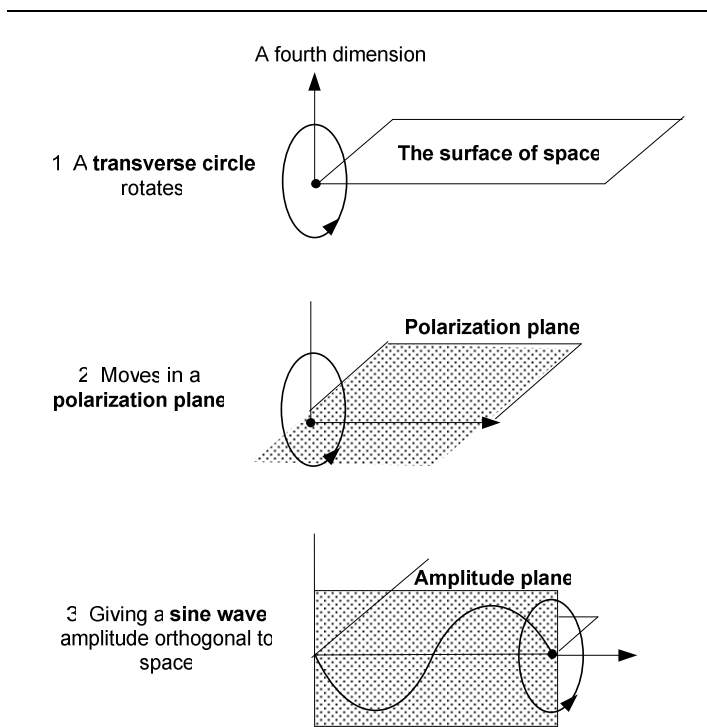


Figure 9. Sine wave projection

of light we see as it moves (Figure 9)<sup>31</sup>.

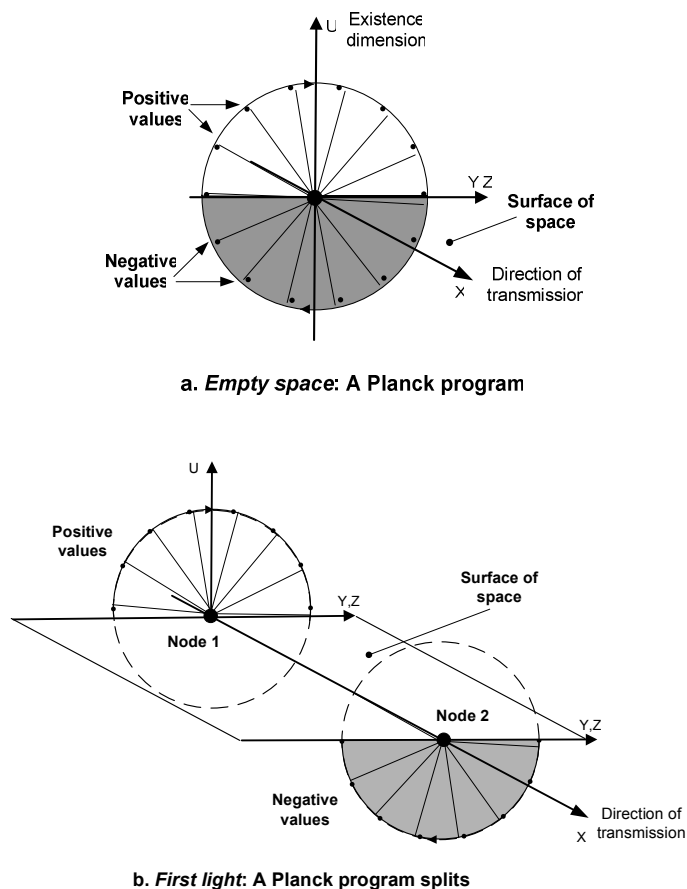


Figure 10. Space and the first light

The grid also keeps photons in sequence, like the baggage cars of a train driven by the same engine. If the engine slows down under load, as when near a massive object, photons go slower *but still keep the same order*, so no photon can overtake another. Were it not so, we could see an object leave then arrive! Our causality depends critically on photons keeping in sequence, which the grid engine rigorously maintains.

### The Planck program

In computing, a central processing unit (CPU) runs a program to tell screen nodes to set the pixel values of an image. Here the grid is both "screen" and "CPU" in our terms, as its nodes both receive input and generate output. The basic grid operation is to "add one" to a discrete rotation transverse to space - a *transverse circle*. The instructions to turn a full transverse circle are a *Planck program*, which projects the sine wave amplitude

Imagine a carnival wheel of black and white values spun by a pulsing machine<sup>32</sup> (Figure 10a). The pattern spun is the program, the machine turning it a grid node and the net effect a world pixel "state"<sup>33</sup>. If a machine turns a full black and white pattern then equal positive-negative values give zero, or equal up-down displacements cancel. So one node running one Planck program per cycle is null processing, i.e. empty space.

But if the same pattern divides over two machines (Figure 10b), each shows first white then black, i.e. the effect is no longer null. Something now "exists", if only for one cycle. The *wavelength* of this highest frequency light is two grid nodes and its *frequency* is half the one-node rate.

The rest of the electro-magnetic spectrum arises as the same Planck program divides among more grid nodes, increasing its wavelength. If no instruction is allocated twice<sup>34</sup>, more nodes in a wavelength running the same Planck program lets each process at a slower frequency<sup>35</sup>.

If a photon's *energy is its node*

*processing rate*, it comes in discrete packets because a higher frequency is one less node to run the same program. So the highest photon frequency, with a two Planck length wavelength, must *double* its energy to reach the Planck energy of empty space<sup>36</sup>. So every photon has zero *rest* mass because it actually is space spread out - if it ever "rested" for its wave train to catch up it would revert to empty space.

### *Inflation*

Suppose in the initial event *one* node "separated" leaving a "hole" in the grid, across whose inner surface it "moved", as a transmitted processing wave<sup>37</sup> [8 p17]. The rip at first spread rapidly, like a tear in a taut fabric, in a cataclysmic chain reaction<sup>38</sup>. So physicists extrapolating the universe's expansion backwards find that for a brief period, called *inflation*, it expanded faster than light [18]. In this model, *inflation was the grid itself ripping apart*.

But the "hole" created also expanded rapidly, weakening the waves on its surface and stopping the chain reaction. Today the ripping has stopped but space still expands and the vibrations on its surface continue. Diluted by the expansion of space, they have descended into lower and lower frequencies, from gamma rays to radio-waves (Figure 11).

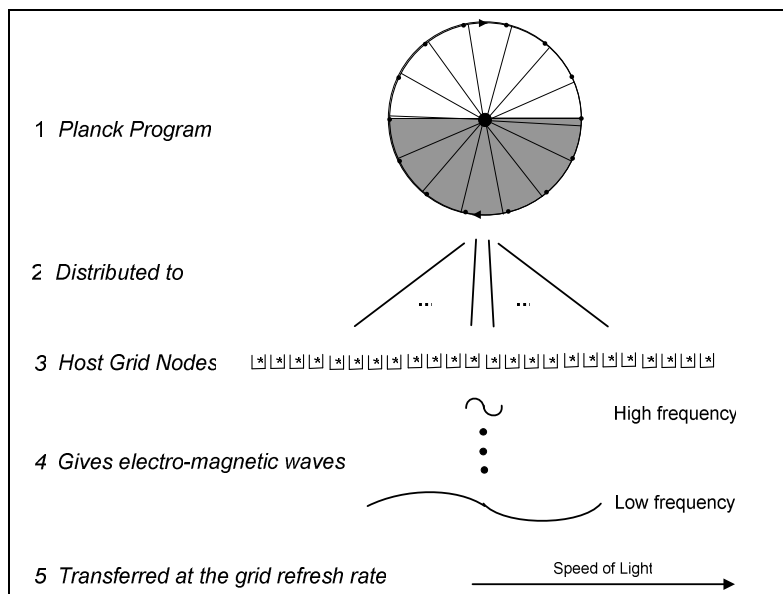


Figure 11. *Electro-magnetism*

So the big bang didn't immediately form a black hole, as a "big crunch" would, because the universe wasn't created all at once, i.e. there never was a point "singularity". In this model, the universe began as a meta-photon in a unit space volume. An unimaginable chain reaction, that will never repeat, then created the rest of it, as quantum waves on the surface of space<sup>39</sup> [29]. So the free information of the universe is, and since inflation always has been, constant.

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### *The size of space*

Planck's constant, the unit of photon energy, also *defines the size of space*: if it were smaller atoms would be smaller and if it were larger quantum effects more evident. Why does one value set both energy and space?

As proposed, Planck's constant depends on the number of grid nodes in a *transverse circle*. As also proposed, a *planar circle* of nodes define the spatial directions of a node "channel". Their number defines a circumference and hence the radius between nodes [5]. If the grid is symmetric, transverse and planar circles have the same number of nodes. Planck's constant links the quantum of energy and the size of space because it is the granularity of the grid behind both.

### *Anti-matter*

If the laws of physics are reversible<sup>40</sup> why isn't time? Here time is not a sequence of static states<sup>41</sup> but the sequence of dynamic choices between them<sup>42</sup>. The sequence can run in reverse if all the choices are reversible, but if quantum collapse is a processing restart, it is irreversible, as a reboot loses all previous data. So no quantum *interactions* can be reversed<sup>43</sup>.

However, *in between interactions* the "add-one" processing of existence can be reversed<sup>44</sup> to give an "opposite" existence, i.e. anti-matter. In Feynman diagrams anti-matter particles enter events going backwards in time. This does not mean anti-matter can reverse its causal interactions, any more than matter can,<sup>45</sup> just that it exists by processing the opposite way. It runs *our* virtual time backwards, but

in *its* virtual time, our time is running backwards. If the difference between processing matter and anti-matter is the cycle direction, the node split that began the universe was the "symmetry breaking" that gave us a matter rather than anti-matter universe<sup>46</sup>.

## Conclusions

Relativity and quantum theory contradict not only common sense but also each other:

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 or evolve in a fixed time [21].
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 objects exist in fixed localities and travel fixed trajectories.

These theories clash because each denies an objective reality assumption the other accepts<sup>47</sup>. In the VR conjecture *both foreground objects and background space-time are processing outputs*.

Indeed, a world of objects that inherently exist is a concept flawed at its foundation. If a photon is a mini-object with hidden parts, they need still finer parts, and so on. If every object contains smaller objects, how can it ever end? That physical objects always arise from other physical objects is like the earth being a disc on the back of a giant turtle. Just as that turtle would need another turtle to stand upon, ad infinitum, so every object would need sub-objects to comprise it. A universe can no more be "objects all the way down" than it can be "turtles all the way down"<sup>48</sup>. The existential buck has to stop somewhere, and in this model, processing is it.

By the logic of quantum theory, between our "real" observations is a quantum unreality of which the Copenhagen doctrine says *we must not speak*. Yet as entities are in-between interactions more than in them, the world exists mostly in uncollapsed quantum states. So by what logic are its brief moments of collapse "real"? *Surely reality is what exists most of the time?*

Or if quantum waves predict and cause physical reality, isn't making a cause "unreal" and its effect "real" backwards logic, like saying the sun circles the earth? If quantum states create physical states, by what logic are they unreal? *Surely reality is that which causes, not that which is caused*<sup>49</sup>?

The denial of quantum reality by physics is doctrinal not logical<sup>50</sup>, against evidence that quantum states are non-physical by nature and quantum collapse is non-physical by origin. Equally, when matter was first attributed to unseen atoms some scientists at first denied it<sup>51</sup>. Then even smaller electrons, protons and neutrons were found inside atoms, and now science even accepts quarks that are forever unseeable. But when quantum theory says the answer to all and everything is a number probability<sup>52</sup>, we cry "*Enough!*" This it seems is a step too far.

It is to this place, that others avoid, the VR conjecture takes us, not to shock or amuse, but to progress. We suppose ourselves in the rational sunlight of physical reality, standing before a dark cave of quantum paradox, but in this model, as in Plato's cave analogy, it is the other way around. It says we are the dark cave of physicalism, with our backs to the quantum sunlight, watching a shadow world projected.

The VR conjecture is neither illogical nor unscientific, nor does it say the world is fake. It is compatible with current physics<sup>53</sup> and also predicts new things about space, time and the universe. If it is true, then our reality must be fundamentally digital.

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<sup>1</sup> In the analogy, people are tied up in a dark cave with their backs to its exit. Looking at the cave wall, they see their shadows, created by sunlight from the outside, and take those projected shadows as their reality.

<sup>2</sup> For example, Fredkin, Lloyd, Tegmark, Campbell, Svozil and Wolfram.

<sup>3</sup> For example: "*Imagine the quantum computation embedded in space and time.*" [2] p172.

<sup>4</sup> McCabe argues that the physical world can't be simulated as follows: "*All our digital simulations need an interpretive context to define what represents what. All these contexts derive from the physical world. Hence the physical world cannot also be the output of such a simulation*" [4]. The logic is correct for static data which needs a viewer context, but not for the dynamic information of this model, which doesn't. See [5] p5 for details.

<sup>5</sup> Biological properties can evolve by autopoietic bootstrapping but existence itself cannot arise the same way. No amount of "emergence" deriving from the interaction of existing parts can create something from nothing.

<sup>6</sup> Berkely developed solipsism from Platonic idealism. It is also called nihilism in eastern Buddhist philosophy.

<sup>7</sup> Distributed entity processing can account for the law of least action, see [8] p19.

<sup>8</sup> By the quantum *indistinguishability* principle, one it is impossible to mark any electron apart from another.

<sup>9</sup> In science fiction terms, *we are the aliens* creating a virtual reality from outside it.

<sup>10</sup> So quantum collapse is not just if we observe the world, but if anything does, i.e. any quantum interaction.

<sup>11</sup> In physicalism things are not conscious. This model is the opposite, as in it *everything* is "conscious". All that distinguishes us from say a rock is just that we can become aware of the consciousness that is everywhere.

<sup>12</sup> Information  $I = \log_2(N)$  for  $N$  *finite* options in a choice. So an information universe must be discrete.

<sup>13</sup> Instantiation of an entity class is an object orientated systems (OOS) method by which identical information "objects" dynamically inherit code from a single program blueprint, e.g. screen buttons instantiating the same class all run the same code. The class can dynamically feed code to its many instances on request.

<sup>14</sup> Actually, a node planar channel overloads, where a channel is a plane through a node. See [8] p 23

<sup>15</sup> Distributed processing allows Huygen's principle, that each *wave front point is a new wavelet source expanding in all directions*. Except a processing wave can also restart at a point, like a particle.

<sup>16</sup> This doesn't repeat the overload because nodes first share and then process. See [8] p16 for the details.

<sup>17</sup> We call it random because it depends upon no previous physical event.

<sup>18</sup> Only at a particular processing cycle does one space "point" necessarily map to one grid node.

<sup>19</sup> See <http://abc.net.au/science/holo/lablife.htm>.

<sup>20</sup> Planck length of  $10^{-33}$  meter is the pixel resolution and Planck time of  $10^{-43}$  second gives the refresh rate.

<sup>21</sup> These are:

- a) 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 it was, the tortoise has moved on.
- b) 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. How can such instants beget movement?

To accept either one is to trip up on the other, i.e. without an infinity of points there can be no continuous movement. Or if there is an infinity of points, the hare can never catch the tortoise.

<sup>22</sup> Though like Mr. A. Square of Abbot's Flatland [13], we struggle to imagine a dimension beyond ours.

<sup>23</sup> One way to imagine a hyperspace is to think of our space but with every point a tiny sphere.

<sup>24</sup> If  $N$  is the grid granularity, the local Planck event angle is  $360^\circ/N$ .

<sup>25</sup> The inner surface of the hyper-bubble is in this model our space.

<sup>26</sup> In this model, lepton and quark matter arise as "standing waves" when meta-light tangles.

<sup>27</sup> For example: "... *we accept as nonexistent the medium that moves when waves of quantum mechanics propagate.*" [16] p56. The VR conjecture in contrast does not accept this as reasonable at all.

<sup>28</sup> Some of course believe this is possible. See our explanation of the credit meltdown [17].

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- <sup>29</sup> Space is *isotropic*, i.e. all directions are equivalent. So it cannot generate positive-negative valences.
- <sup>30</sup> The Michelson–Morley experiment denied the idea of a physical ether, but the idea of a non-physical ether has never been contradicted. Indeed that space is filled with an invisible essence has waged a vigorous comeback.
- <sup>31</sup> If our space is a surface, light really does oscillate into an “imaginary” dimension outside "real" space, as complex number theory says. In this model, the mathematics is not just a "convenient fiction".
- <sup>32</sup> The physical analogy is to help understanding only, and should not be taken literally.
- <sup>33</sup> In this model, a pixel is a quantum state.
- <sup>34</sup> The principle of conservation of processing is that every entity program instruction is always allocated to run on the grid. It is proposed to underlie all our partial conservation laws.
- <sup>35</sup> In current physics,  $E \cdot \lambda = h$ , with E energy,  $\lambda$  wavelength and h Planck's constant. In this model, that the total processing of the wavelength (Planck's constant) equals the processing rate per node (energy) multiplied by the number of nodes (wavelength) is self-evident.
- <sup>36</sup> This bears on what physics calls the "hierarchy problem".
- <sup>37</sup> In this model, the inner surface of the grid "hole" began our space and the "first photon" began our universe.
- <sup>38</sup> In this model, a packet transferred once per node cycle travels at the speed of light. In inflation, each transfer immediately "rips" the receiving node apart, before it can process any cycle. So this chain reaction occurs at the node transfer rate, i.e. much faster than the speed of light, e.g. estimates of a  $10^{50}$  increase in  $10^{-33}$  seconds.
- <sup>39</sup> It is the *interaction and overload* of these processing waves on the grid that simulates our physical world.
- <sup>40</sup> Including the equations of quantum mechanics.
- <sup>41</sup> In what Barbour calls a "time capsule". He argues that states must exist in a "timeless" universe [19].
- <sup>42</sup> In a "*Physics of Now*" [20] p101, each "state" is equivalent to another choice.
- <sup>43</sup> This includes all "observations".
- <sup>44</sup> The basic grid existence operation, to "add one" to a transverse rotation, is asymmetric with respect to the hyper-surface, i.e. one can also "subtract one". Only if existence is processing can it be run in reverse, as anti-matter does.
- <sup>45</sup> This model preserves the causality and unpredictability that the following paradoxes demand:
- 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.
  - 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.
- Time as grid processing is causal and events as node reboots are unpredictable, i.e. there is no time travel.
- <sup>46</sup> The first value in the forward direction can be "out" or "in" with respect to a sphere surface. This choice defines the "matter" of our universe, leaving "anti-matter" just a possibility. So there is no need to wonder "Where did all the antimatter go?" as current physics does. It didn't go anywhere because it never was.
- <sup>47</sup> In the story of the stranger, a father and son boarded a train and had meals where another man congenially joined in and ate their food. When the father asked the son "Is he your friend?" he replied "Wasn't he your friend?" The stranger then took off and was not seen again. The story shows how assumptions install themselves.
- <sup>48</sup> In this apocryphal story, a scientist lecturing that the universe depended on nothing outside itself was challenged by a little old lady who said it sat on the back of a giant turtle. He laughed, and asked her what the turtle was standing on, but got the reply "*Sonny, it's turtles all the way down*".
- <sup>49</sup> As Penrose says: "*How, indeed, can real objects be constituted from unreal components?*" [22] p313
- <sup>50</sup> The nineteenth century doctrine of positivism has become a religious canon. Yet science is a way to study reality not a belief about it. It is a way to ask questions not a set of answers. See <http://researchroadmap.org>
- <sup>51</sup> For example, Ernst Mach denied that atoms existed.
- <sup>52</sup> In Douglas Adams "The Hitchhiker's Guide to the Galaxy", the computer Deep Thought after millennia of calculations found that the answer to life, the universe and everything was 42. It was, of course, a joke.
- <sup>53</sup> And its equations, which are then just the mathematical expression of the program logic outlined.