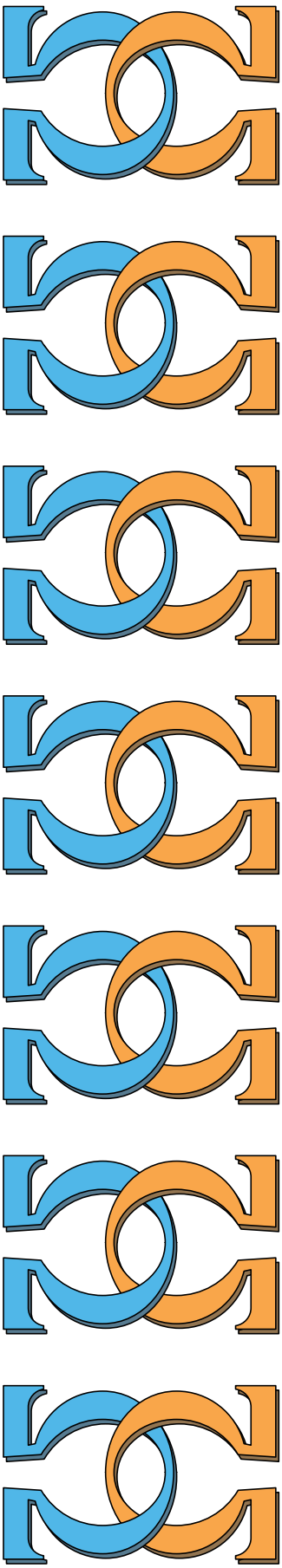

CDMTCS
Research
Report
Series

The Light of Existence

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CDMTCS-390
August 2010

Centre for Discrete Mathematics and
Theoretical Computer Science

The Light of Existence[1]

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"There is a theory which states that if anyone discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable. There is another theory which states that this has already happened." (Adams, 1995)

ABSTRACT

This paper derives the properties of light from the properties of processing, including its ability to be both a wave and a particle, to detect objects it doesn't touch, to choose a route after it arrives, to take all paths to a destination and to spin in any direction both ways at once. In this model the quantum wave is a processing wave instantiated from an entity class, and quantum collapse is when a class stops all its instances to merge with another. This approach gives insights into entanglement, superposition and the measurement problem, but has the conceptual cost that non-physical quantum states are real.

INTRODUCTION

A previous paper presented three-dimensional space as the surface of a hyper-sphere[2] bubble that began with the "big rip" (Whitworth, 2010). The first light then arose when the "atoms of space" (Bojowald, 2008) moved on this surface. In this paper light, or more exactly electro-magnetism, is the archetype of existence, half-way between space, which doesn't exist to us and matter which does. In this model, all physics, including time, space, mass, charge, energy, spin and gravity, is the output of a processing network Wilczek calls *The Grid,* which is the "… *primary world-stuff*" (Wilczek, 2008) p74. This grid is not what we see, but what creates what we see. Its processing nodes set reality "pixels" at a finite refresh rate, but our computing is just an analogy, as even to simulate a few hundred atoms a conventional computer:

"… *would need more memory space that there are atoms in the universe as a whole, and would take more time to complete the task than the current age of the universe.*" (Seth Lloyd, 2006) p53.

Only quantum computers can approach this processing power, and they do so by tapping the same grid source. The grid is not proposed to be a computer as we know it, but the original existence which creates and maintains our physical world as a local reality[3].

Light is now presented as a processing wave on the hyper-surface of our space, that can no more leave it than a water wave can leave a lake surface. In the next paper, light waves tangle into the permanent "standing waves" we call matter, but this paper considers why light:

1. *Never slows or weakens.* Why don't light waves fade, even after billions of years?
2. *Has a constant speed in any material.* Why is the speed of light always a constant?

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[1] Latest version always available at http://brianwhitworth.com/BW-VRT3.pdf

[2] As a circle can rotate to give a sphere, so a sphere can be rotated to give a hyper-sphere. While hard to imagine, it is mathematically well defined. Three-dimensional space is here just a surface of four-dimensional bubble expanding into a larger bulk, i.e. a "hyper-bubble universe".

[3] A local reality, like a simulated world, appears real to its inhabitants but is contained by another reality which generates it. In contrast, an objective reality exists in and of itself and is not contained by anything.

3. *Comes in minimum packets.* Why is light, which is a wave, "lumpy"?
4. *Moves like a wave but arrives as a particle.* How can light be both a wave and a particle?
5. *Always takes the fastest path.* How do photons know *in advance* the fastest route direction?
6. *Chooses its path after it arrives.* Is this backwards causation?
7. *Can detect objects it never touches.* How does non-physical knowing occur?
8. *Entirely passes a filter at an angle to its polarization*? How can all the photon get through?
9. *Spins on many axes and in both ways at once.* What is quantum spin?

These, and other properties of light, fall naturally out of this model.

LIGHT AS AN INFORMATION WAVE

In the seventeenth century, Huygens noted that light beams at right angles go right through each other so they must be waves, as if they were objects like arrows, they would collide. He saw light as an expanding wave, where each strike point was the centre of a new little wavelet traveling outwards in all directions. As the wavelets spread, he argued, they interfere, as the trough of one wave cancels the crest of another. The end result is a forward moving envelope that at a distance from the source acts like a "ray" of light (Figure 1a). Huygen's principle, that each *wave front point is a new wavelet source expanding in all directions,* explained reflection, refraction and diffraction. Newton's idea of bullet-like corpuscles traveling in straight lines explained only reflection and refraction (Figure 1b), but his simpler idea carried the day.

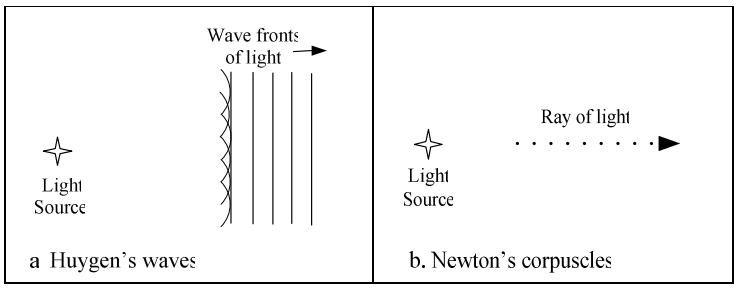

Figure 1. Huygen's waves and Newton's corpuscles

Two hundred years later Maxwell again argued again that light is a wave with a frequency and wavelength, but then Planck and Einstein argued equally convincingly that it comes in particle-like packets. The theory of light has swung from Huygen's waves, to Newton's corpuscles, to Maxwell's waves, to Planck packets. Today we *pretend* that light is both wave and particle, but no-one knows how that can be. Three hundred years after Newton, the question "*What is light?*" is as controversial as ever. As Einstein said to a friend just before he died:

> "*All these fifty of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta?' Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken*." (Walker, 2000) p89

Even today, no-one really knows what light actually is.

The properties of light

The properties of light are now expressed as the properties of processing.

Electromagnetism

In the current view of physics, light vibrates an electro-magnetic field that fills all space, and which also causes electricity and magnetism. So a light wave sets equal positive and negative electric and magnetic potentials, at right angles[4]. If this wave oscillates slowly, it is radio and television waves,

[4] The next paper takes electric and magnetic fields as aspects of one thing, as is also generally believed.

if faster it is heat and light, and if very fast it is x-rays and nuclear rays (Figure 2). *Visible light* is the small part of the spectrum that vibrates about a million-billion times a second. Low frequency radio waves vibrate only a few times a second, while high frequency gamma rays oscillate a billion times faster than visible light. In this model, all electro-magnetism is the same processing running at a different rate, so it will for simplicity be just referred to as "light".

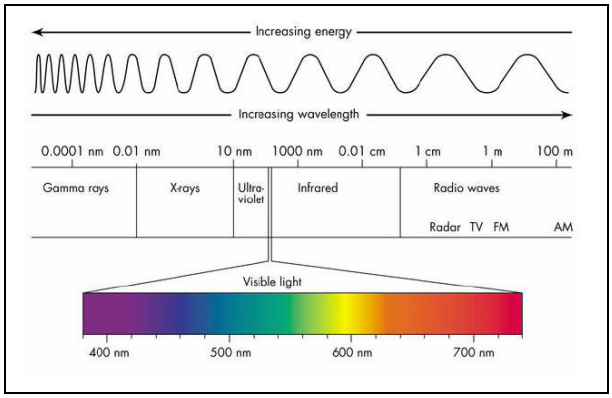

Figure 2. The electro-magnetic spectrum (http://www.antonine-education.co.uk/)

Light is a wave because separately visible but out-of-phase beams can interfere to give absolute darkness. A normal flashlight can't do this, but when lasers polarize light, individually visible beams can combine to give absolute darkness. This *light + light = darkness* is only possible for waves, not particles.

A wave of nothing

In current physics, light is a sine wave whose amplitude is expressed as a complex rotation in "imaginary" space. A rotation is an angular acceleration, e.g. consider a wave on a pond surface (Figure 3) that begins flat, then the wave pushes a molecule say up, then gravity pulls it back down, then water elasticity pushes it back up, etc. For a surface molecule to accelerate up needs a force, and to then accelerate down needs an opposing force. So physical waves involve an initial energy source, like the earthquake that creates a tsunami, then the wave oscillates between the opposing forces of gravity and elasticity, until eventually it fades by friction. Viewed from the side, the wave just moves atoms up and down, but run the frames together and a wave "moves" across the surface. What moves in the wave direction is the pattern, not individual water molecules.

We know the photon is a wave, and that waves vibrate in a medium. So a light wave can't occur in nothing, as *something must move to create it*, but without a physical "ether" physicists simply *declare* that light vibrates "nothing":

"*… we accept as nonexistent the medium that moves when waves of quantum mechanics propagate*." (Laughlin, 2005) p56.

In current theory, light is an oscillation between opposing electric and magnetic fields. No reason is given for these fields, whose action is assumed to be frictionless. Electric field changes are proposed to cause magnetic field changes which cause electric changes, as a "… *self-renewing field disturbance*." (Wilczek, 2008) p212. This begs the question of what renews the fields that renew? That the electric field powers the magnetic field which powers the electric field, is like Peter paying Paul's bill and Paul paying Peter's bill. If the big bang began all light, could it then, once started, vibrate forever[5]? Not as a physical wave, as the second law of thermodynamics demands energy loss by friction, with no exceptions. Any wave that travels in a physical medium eventually dies out unless reinforced, so light as a "frictionless wave" is *unlike any physical wave we know*.

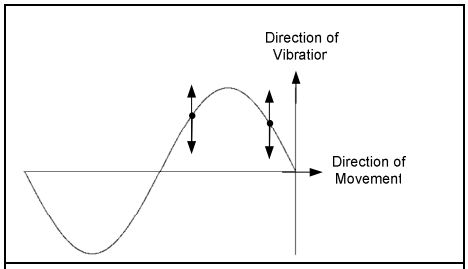

Figure 3. Wave particles accelerate

The current view that light arises when theoretical fields in empty space self-renew without friction, as a *frictionless wave of nothing,* is hardly a satisfactory explanation.

[5] One might observe that planets orbit forever, but the gravity causing this is here proposed to derive from the same grid source as light.

In this model, a photon is like a water wave except that what moves "up" and "down" are information values set not physical atoms. Each grid node just sets the values allocated by its processing, with no friction, and the wave pattern we call light emerges as "moving". Light then is a processing wave moving in a processing grid "medium" that is both "nothing" and "something". It is nothing when it's null processing is empty space, and something when it's processing manifests as light or matter.

Light everlasting

Light moves at the fastest possible speed but never tires, like a man living luxuriously with no visible means of support. Ancient light, like cosmic background radiation from the big bang, has traveled the universe for billions of years when it hits our telescopes, but still arrives at the speed of light and with the correct energy for its frequency. It gets "colder" because the expansion of space increased its wavelength, but its amplitude doesn't diminish as it travels, or old light would have less energy than new light (for the same frequency). Light always arrives as "fresh" as when it left, so if it is a physical wave, then it has found the secret of perpetual motion.

In this model, light is processing distributed across an active processing grid, so all its transfers are by the nature of information, frictionless. Water waves die out because they *give* energy to move the physical atoms that create the wave pattern, which involves friction. In contrast, here light *borrows* grid processing that always runs anyway, so it never fades. Light then is continuously maintained by the processing of the ever active grid that transmits it. Note that this grid doesn't itself exist in space or time, as its information transfer channels create space and its processing sequences create time. Equally, the photon is not a "thing" that exists inherently in space but just a disturbance on its surface.

The speed of space

Physics doesn't really explain why the speed of light is a constant in any physical medium:

"*… the speed of light is a constant because it just is, and because light is not made of anything simpler*." (Laughlin, 2005) p15

Recall that Einstein *deduced* that the speed of light is a maximum from how the world behaves but didn't *derive* it from any theory of light or the world. In this model, light has a constant speed because it is moved by the grid itself. Whether in a vacuum or a transparent material, light it is always passed on once per local grid cycle. This keeps photons in sequence behind each other, like the baggage cars of a train driven by the same engine. If this engine slows down, as near a massive object, the photons go slower *but still keep the same order,* so no photon ever overtakes another. This is fortunate as otherwise one could see an object leave, then see it arrive! The temporal causality of the physical world depends critically upon the sequence of photon processing, which the grid maintains.

The speed of light then is not a property of light, but of the actively processing grid that transmits it. It moves faster in a vacuum than in transparent matter because matter uses up the same grid processing that transmits light. While matter can acquire a movement property, light cannot, because it doesn't move but rather is moved. So while matter needs energy to *start* it moving, light needs energy to *stop* its transfer by the grid. A later paper contrasts the *forced movement* of matter and the *effortless movement* of light. If the speed of light is not a property of light, it should be called the *speed of space,* as it is the grid transfer rate.

Light vibrates outside space

If light waves oscillate, do they do so in physical directions, as sound does? To an objective realist the question is senseless, as how else could it vibrate? Yet consider the facts. Sound is a longitudinal wave that expands and contracts physical air molecules in its travel direction, so there is no sound in empty space. In contrast, light is a transverse electro-magnetic wave, vibrating at right angles to its line of travel that still shines in space, or we couldn't see the stars at night. Also, light bouncing around space is *isotropic* – it has no constant up or down or left or right. Space doesn't distinguish direction, as

up from one view is down relative to another. Light as a transverse vibration in space *can't* give positive or negative absolutes, but electric and magnetic values are absolutely positive or negative. So if light vibrates transversely *in space*, it cannot manifest as electro-magnetic vibrations do. It is now proposed that light vibrates transversely *outside "real" space.* This is possible if our space is a hyper-surface, as it can then have absolute positive-negative values as a ball surface has dimples or dents. In this model, photons vibrate on the "surface" we call space.

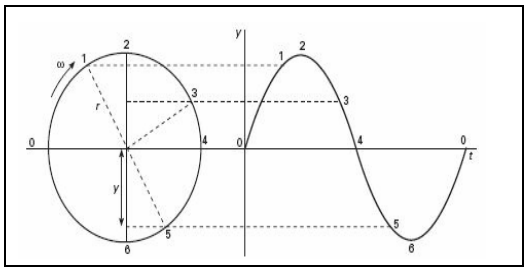

Figure 4. A circle gives a sine wave

A moving transverse circle is a sine wave

Modern lasers can reduce the many frequencies and polarizations of light to one frequency, one plane and one pulse, i.e. a *photon.* A photon varies in strength as a sine wave, which mathematics can map to a point rotating on a transverse circle (Figure 4). So the sine wave light presents in our space could project from a rotation outside it.

To see this, consider how 3D objects might seem to a flatlander on a two-dimensional surface, e.g. a ball dropped through the flat surface would look like circles expanding and contracting. A turning transverse wheel moving its centre on the flat surface would seem to a flatlander as a sine wave. Similarly, a transverse rotation moving on the surface of our space would project a sine wave onto it (Figure 5).

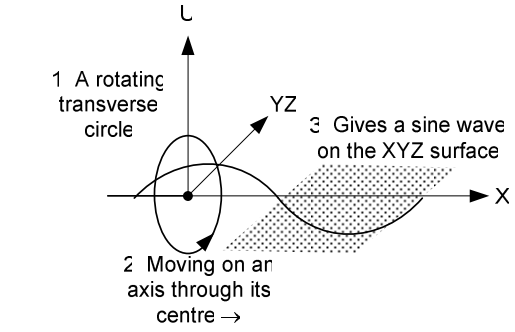

Figure 5. A transverse circle in quantum space

This suggests why complex numbers successfully describe light waves as rotations in an "imaginary" dimension outside our "real" space (Figure 6), with one imaginary unit being one rotation[6]. What is usually considered to be a mathematical convenience is here literally what happens: *light actually is a moving rotation into an imaginary dimension beyond our "real" space.*

So complex numbers really do exist:

"*In quantum mechanics there* ***really are*** *complex numbers, and the wave function* ***really is*** *a complex-valued function of space-time.*" (Lederman & Hill, 2004) p346

In this model, the imaginary complex plane of light's sine wave is the fourth dimension of a quantum space that contains our space as a surface.

Fields as dimensions

Does light vibrating in a dimension outside space contradict the field concept that permeates physics today? Not if one accepts Feynman's view of what a "field" is:

"*A real field is a mathematical function we use for avoiding the idea of action at a distance.*" (Feynman, Leighton, & Sands, 1977) Vol. II, p15-7

For example, the earth holds its moon in orbit by a distant acting force, which we attribute to a gravitational field in the space around it. Faraday's nineteenth century fields attach a value to each point

[6] The imaginary dimension has units *i,* where *i times i* = -1. In normal multiplication, 5 multiplied by 4 *repeats* it four times to give 20. In complex numbers multiplying 5 by *i rotates* it by 90° into imaginary space (Figure 8). Multiplying 5 by 4*i* rotates it by 90° four times, which gives the original 5 again.

of space, i.e. add a degree of freedom to it. So gravity is a useful explanatory construct, not an observed reality, as one sees its effects not gravity itself. Over time, fields have come to be accepted as "real", and modern versions invoke exchange "particles" to cause their effects: electro-magnetic fields use photons, weak nuclear fields use W and Z bosons, strong nuclear fields use gluons, gravity uses gravitons and the Higgs field has the Higgs or "God" particle. While this reassures us that only particles cause forces, no gluons, gravitons or Higgs particles have ever been detected.

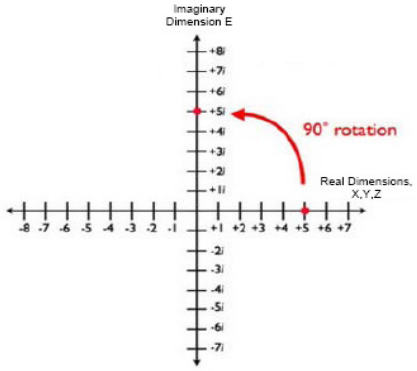

Figure 6. Complex rotations

In this model, "particles" are events not things, and a field is just a useful theoretic device that can be replaced if another concept works better, i.e. explains more for less. If a field permeating all space gives a value to each point in it, a dimension orthogonal to space does the same. Both *add a degree of freedom to space,* i.e. something beyond it, e.g. that an electric field still has a value even without any charges present implies something beyond space exists. Yet while inventing a new field is trivial, each new dimension compounds system complexity enormously, e.g. string theory with only ten extra dimensions has an estimated 10^{500} possible architectures. Fields as mathematical fictions can multiply without regard to explanatory cost, but extra dimensions cannot. Yet physics agrees that a theory of everything must unify all fields, i.e. reduce them all to one. This equates to one extra "existence" dimension underlying electricity, magnetism and gravity, as proposed here.

Mathematically the unseen dimension of this model is just a degree of freedom beyond space into which values are set. Physics has called these values vector potentials/phases (Feynman), probability amplitudes (Born) and quantum potentials (Hiley) (Davies & Brown, 1999) p138. Philosophy also has concepts for what is beyond space, like Spinoza's universal essence (Spinoza, 1985). In this model, the values set are just those of a simulated reality.

The electro-magnetic process

Virtual worlds have pixels, processing and programs. In our simulations, a central processing unit (CPU) directs screen nodes to process different pixel values to give an image. The CPU reads a program to execute its commands which direct screen nodes to adopt various pixel values. The previous paper argued that simulating a world like ours requires distributed processing, making the grid proposed both "screen" and "CPU", in our terms. In this model, *the pixels are quantum states, the processing is done by an unseen grid, and the programs are the equations of quantum theory.*

The basic operation

In our computing, each CPU has a *command set,* of its hardwired processing operations. Our initial trend to complex instruction set computing (CISC) was reversed when it was found that reduced instruction set computing (RISC) is more reliable. The command set proposed for the grid is the ultimate RISC design of just one basic operation, namely:

The sequential setting of a circle of values in a fourth dimension transverse to space.

Setting this *transverse circle* of values has the advantage of being continuous, as the end of a cycle is also its beginning, so no end point needs to be stored. As this basic rotation is transferred between grid nodes each "vibrates" the surface of space, setting positive values above the surface or negative ones below. The net surface displacement each node cycle is a "quantum existence pixel" or state.

Running this basic operation once per cycle then gives a net zero displacement to match the state of empty space, which is empty but: "... *the vacuum state is actually full of energy...*" (Davies &

Brown, 1999) p140. Existence as a processing output explains how this can be, as a null processing cycle produces nothing, but is still an active process.

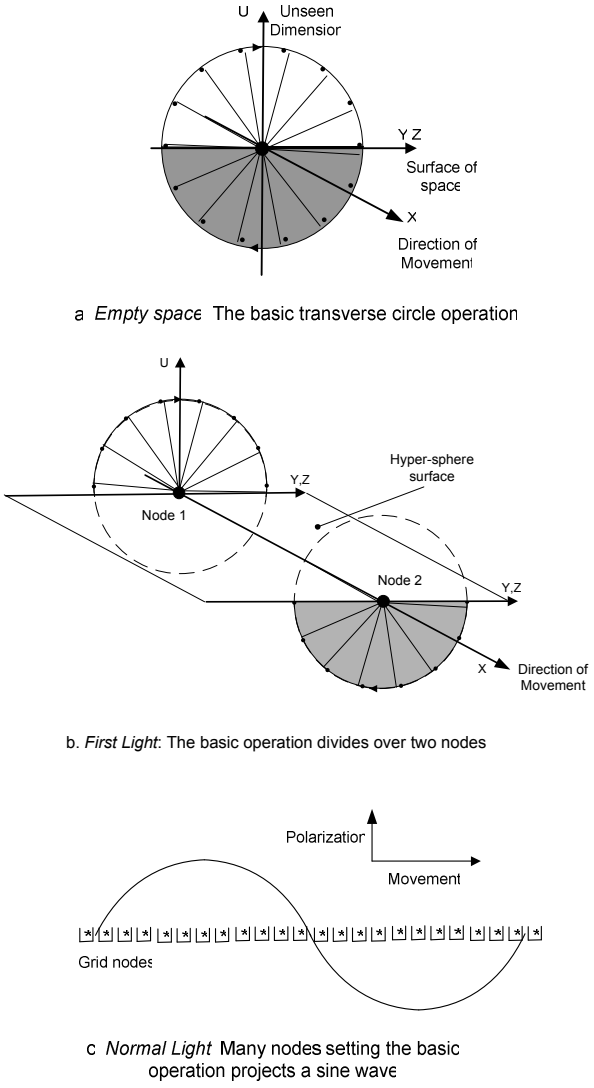

Figure 7. Processing space and light

Consider the analogy of a carnival wheel of equal black and white values spun quickly by a machine[7] so one sees only a blur each time it spins (Figure 7a). Here the wheel pattern is the basic operation, the machine turning it is the host grid node and the net visual effect is a world pixel or quantum state. If one full wheel cycle turns on one machine, the equal black and white values cancel out giving the empty value of space.

Processing frequency

In the previous paper, the *first light* arose at the big rip, when a node of the original existence spread its activity across two nodes of the surface created. In the carnival wheel analogy, the original full pattern divides across two wheels, each turning on its own (Figure 7b). Each machine turns its half of the original pattern once and passes it on. Now, each wheel first shows white then black, i.e. the results no longer cancel. In processing terms, a basic operation carried out by two grid nodes instead of one is no longer null processing, i.e. the first light "exists". Its *wavelength* is the number of grid nodes needed to process the basic operation, in this case two. Its *frequency* is the rate at which each host node processes values, in this case half a basic operation per cycle, which is half as fast as the original process.

The rest of the electro-magnetic spectrum can now be derived by distributing the same basic process among more nodes, increasing its wavelength and reducing its frequency in each node (Figure 7c). The entire electro-magnetic spectrum, from radio-waves to gamma rays, is proposed to arise as the same basic process distributes among more grid nodes.

Energy as a processing rate

Energy, like space and time, is a theoretical construct that works, but no-one really knows what it is. Consider now an information processing model of energy.

The ultra-violet catastrophe

Nineteenth century physicists knew that higher light frequencies had higher energies, with a ratio as it turns out of the frequency squared. So a higher electromagnetic frequency range should have more

[7] This mechanical analogy is just to help understanding, but should not be taken literally. There are no actual physical wheels or mechanisms that turn them. In this model everything is processing.

energy than an equal low frequency range. For black body objects, that absorb and emit light at all frequencies, increasing temperature should affect the energy of higher light frequencies more, giving what physicists called the ultra-violet catastrophe, of too much energy at higher frequencies, e.g. an enclosed furnace is a black body as radiation bounces around inside it to create every frequency, so opening a hot furnace should give a fatal dose of x-rays, but in practice it doesn't.

Planck proposed that radiation was discontinuous, so atoms can only emit photons whose energy is an integer multiple of a basic "quanta"[8]. So atoms need a certain energy to emit each higher frequency photon, and never get enough energy for the highest frequencies, which predicts black body radiation correctly. Einstein then deduced from the photo-electric effect that this is not a property of the atoms, as Planck thought, but of light itself. Electro-magnetism always comes in energy "packets", set at its frequency times Planck's constant[9]. That Maxwell's waves were discrete not continuous was unexpected and why electro-magnetism emits and absorbs in fixed units is a mystery to this day.

Energy as the grid node processing rate

In this model, electro-magnetism is the same basic process distributed across many grid nodes, whose number or wavelength defines whether we register gamma rays, x-rays, light, heat or radio waves. As the wavelength increases, each node has less processing to do each cycle, i.e. it runs at a slower rate. If *a photon's energy is its grid node processing rate,* high frequency photons that set values faster will appear to us as more energy, while as the wavelength increases each node has to do a smaller share of the processing, i.e. has less energy

In computing, any basic processing operation, like a CPU command, must complete once begun. Likewise, each node in a photon wave still completes the full basic operation, but does so over many of its cycles. Each node receives the entire calculation, but only sets some of its values each cycle. *Distributing processing makes it run slower not less*, so each node still runs the full process, but does so over many of its cycles. Energy then comes in discrete packets because each higher frequency is one less wavelength node to run the same processing amount. As a photon's energy times its wavelength is Planck's constant, so the processing rate per node over its wavelength must sum to the basic *Planck process*. So over its wavelength, a photon runs all its processing all the time, i.e. *it fully exists*.

Potential energy

Landauer first connected information and energy by showing that all irreversible processing, like erasing a bit, dissipates energy (Bennett, 2003). So the computational capacity of a physical system depends on the energy available to it (S. Lloyd, 2000). The Margolus-Levitin theorem specifies how energy limits the rate of system state changes (Norman Margolus, 1998), so more powerful computer chips generate more heat. Yet while kinetic and radiant energy connect to information processing rates, what about potential energy?

Physicists treat potential energy like a bank account, so an object raised up deposits energy into an omnipresent energy account, which returns it later when it falls. Potential energy keeps the total energy of the system constant. Unless it is just a fudge to balance the books, something must exist to keep the account. A grid that is ever-active and everywhere available could accept and refund potential energy processing credits, except for a black hole, when the account is fully drawn. The grid whose channels create spatial directions, whose processing sequence creates time, and which is the medium of light, could also be the potential energy bank account.

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[8] The word quanta just means "a discrete amount". This amount is now called Planck's constant.

[9] Or $E = h.f$, for energy E, frequency f, and Planck's constant h

The size of space

Plank's constant also *defines the minimum size of space:* if it were smaller atoms would be smaller and if it were larger quantum effects would be more evident. Why does the basic unit of photon energy also define the granularity of space?

In this model, energy is the rate grid nodes process a basic *transverse circle* of values. If Planck's constant represents the processing of one complete circle, it depends on the number of values in that circle. Previously, the directions of space were derived from grid *planar circles*, a node's transfer neighbors in a plane (Whitworth, B., 2010). The number of nodes in a planar circle defines a circumference in space which defines a radius, i.e. the distance between grid nodes.

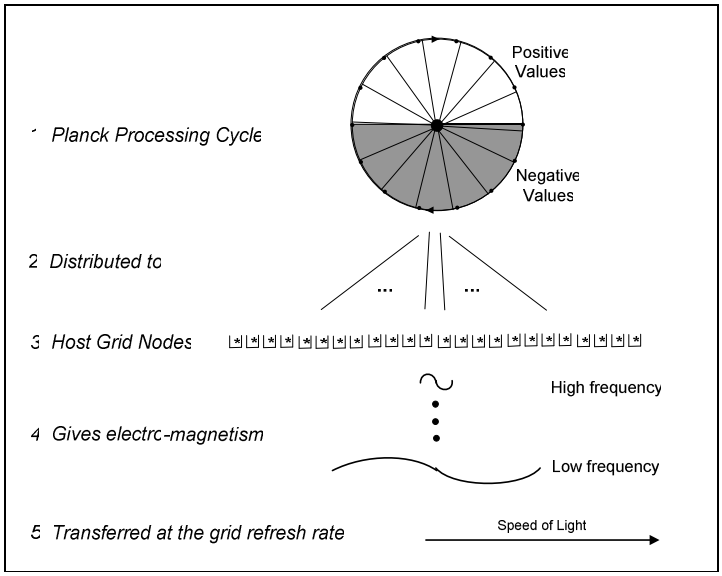


Figure 8. The Planck process model

In a symmetric grid transverse and planar circles will be the same size, i.e. involve the same number of nodes. So Planck's constant, the energy of one transverse circle rotation, will also define the planar circle circumference that sets the size of space. Planck's constant links the quanta of energy and the pixel size of space because it defines the density of the grid that creates both energy and space.

Partitioning the Planck process

In this model, electro-magnetism arises when a basic *Planck process* is partitioned among many grid nodes, as shown in Figure 8. An original process, descending into lower and lower frequencies by the expansion of space, is passed on by the grid at its refresh rate which is the speed of light. In this model, Planck's constant is the basic grid processing operation and the speed of light is the basic grid transfer rate.

Light then is the processing of empty space spread over more grid host nodes to run at a slower rate, i.e. the frequency of light is always less than the frequency of space. A photon has zero *rest* mass because it is the processing of space spread out in space, so if light ever rested at a node for its wave train to catch up, it would become empty space. In this model, higher electro-magnetic frequencies will be harder to come by, and the highest possible frequency will have a wavelength of two Planck lengths. This maximum frequency is still just half the processing capacity of pure space. It would have to double its energy to achieve a higher frequency, which would then turn it into space.

Delivering processing

When a photon hits a photographic plate, its energy initiates a chemical reaction that produces a dot. Yet the energy of a physical wave is spread over its wavelength, so as it hits a barrier it should take time to arrive. If light were a physical wave, a detector would have to wait for the rest of the wave to arrive to get all its energy. This isn't long to us, but radio wavelengths are many meters long and billions of quantum cycles. What if it hits something else in the meantime? The problem is:

"*How can electromagnetic energy spread out like a wave … still be deposited all in one neat package when the light is absorbed?*" (Walker, 2000) p43

In quantum mechanics, a photon delivers *all* its energy *instantly* at a point. This is impossible for a physical wave but not for a processing wave. As *every* node of this wave runs exactly the same Planck

process there is nothing to be "gathered" over its wavelength, so *any point* can instantly deliver all its processing. Why this can't occur in two places at once is covered in the next section.

WAVE-PARTICLE DUALITY

Quantum theory challenges our traditional ideas of how light exists.

Young's double slit experiment

Over two hundred years ago Thomas Young carried out an experiment that still baffles physicists today - he shone light through two nearby slits to get an interference pattern on a screen (Figure 9). Since only waves diffract like this, light must be a wave. Yet photons going through one slit each hit at one point, with no half-strikes. If light is a wave, how does it hit at a single point? Or if it is a ray of corpuscles, how does it interfere?

To resolve this, modern physicists sent light through Young's two slits *one photon at a time*. Each photon still gave only one dot, as expected, but then the dots built up into the familiar interference pattern, whose most likely impact point is directly behind the barrier between the slits! The effect is independent of time, e.g. one photon shot through the slits per year still gives a diffraction pattern. As each photon can't know where the previous one hit, how does the pattern emerge? Or if one photon interferes with itself, how does it hit at a point?

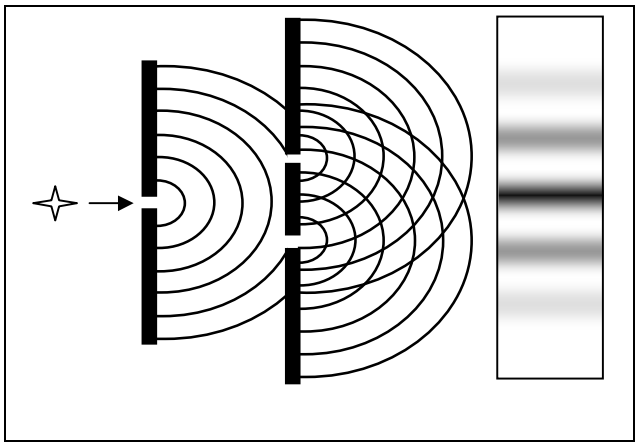


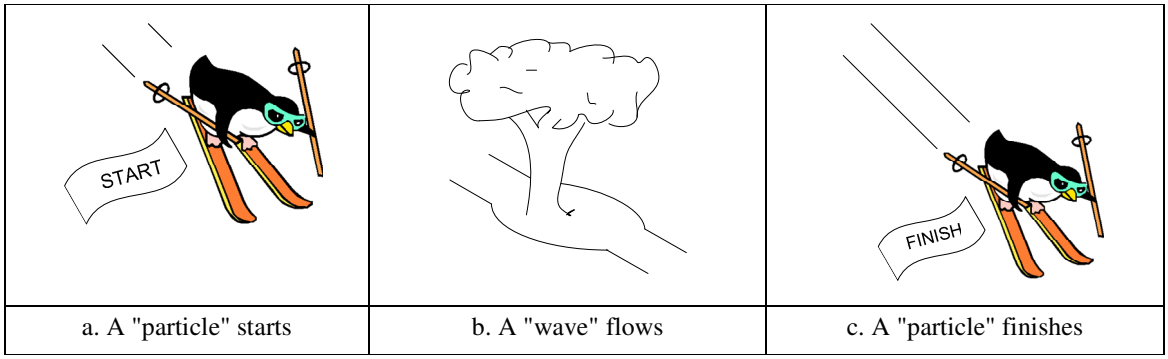
Figure 9. Young's double slit experiment

In an objective world one could just check which slit a photon went through, but in our world, if detectors are placed in the slits to see where photons go, each just fires half the time. Photons *always* go through one slit or other, and *never* go through both slits at once. In nature's conspiracy of silence, if we observe a photon it is always a particle in one place, but when we don't look it acts like a wave in many places. That a photon created and detected at a point, can travel as a spread-out wave, is like a skier going around both sides of a tree but crossing the finish line intact (Figure 10).

The problem can be stated simply:

1. *If light is a wave*, why doesn't it smear over the detector screen as a water wave would do?
2. *If light is a particle,* how can one at a time photons create an interference pattern?

Further, Young's diffraction doesn't just occur for photons, but is also found for electrons, atoms



a. A "particle" starts	b. A "wave" flows	c. A "particle" finishes

Figure 10. Wave-particle duality

and even large molecules (M. Arndt, O. Nairz, J. Voss-Andreae, C. Keller, & Zeilinger, 1999). Any quantum entity can interfere like a wave then appear as a particle. As Feynman says:

"*… all the mystery of quantum mechanics is contained in the double-slit experiment*."
(Satinover, 2001) p127.

The Copenhagen kludge

After centuries of wave-particle conflict, Bohr and others suggested the compromise that wave and particle views of light are "complementary", i.e. both true. This truce still holds today:

"*…nobody has found anything else which is consistent yet, so when you refer to the Copenhagen interpretation of the mechanics what you really mean is quantum mechanics.*" (Davies & Brown, 1999) p71.

It conveniently lets physicists use the appropriate formula as needed. In this *"Don't ask, don't tell"* policy of science, reality can be a wave when we don't look as long as it is a particle when we do. The Copenhagen analysis enshrined the idea that light is both wave and particle, even though everyone knows that a particle isn't a wave and a wave isn't a particle. In no physical pond do rippling waves suddenly become "things" when observed. Yet this "big lie", *that light is a wavicle,* has been very effective, as Gell-Mann noted in his 1976 Noble Prize speech:

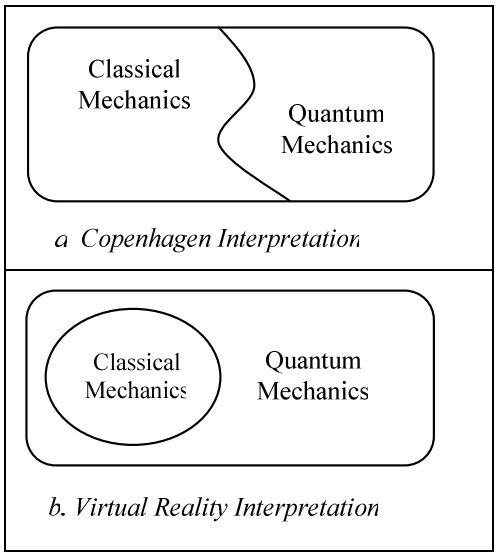


Figure 11. Duality and Non-duality

"*Niels Bohr brainwashed a whole generation of physicists into believing that the problem (of the interpretation of quantum mechanics) had been solved fifty years ago.*"

Yet the mystical wave-particle duality of Copenhagen is essentially a kludge of two ideas that contradict at their core, a theoretical marriage of convenience between waves and particles whose irreconcilable differences can't be denied. Like the mind-body dualism of the first paper (Whitworth, B., 2010), the classical-quantum dualism of modern physics *pretends* that incompatible domains are separate but equal (Figure 11a). Yet privately Bohr stated that *there is no quantum world* and we just *imagine* quantum equations are real to get results. Yet isn't using quantum states but denying they exist like taking goods from a foreign factory while saying "overseas doesn't exist". If quantum theory is good enough to use, it should be good enough to believe in, even if it:

"*… paints a picture of the world that is less objectively real than we usually believe it to be*." (Walker, 2000) p72.

Bohr hedged his bets between physical and quantum reality, but this model backs quantum reality entirely. In this *non-dual view* there is only one real world, which is the quantum world, and classical mechanics is the special case of quantum interaction (Figure 11b) (Audretsch, 2004) p14. Here classical mechanics describes the physical world stage and quantum mechanics the behind-the-stage machinery creating it. So photons exist as probability waves, exactly as quantum theory says they do, but the physical world doesn't exist as we think it does, as static "things" that objectively exist. Instead, the physical world is an information transfer, like an image thrown up on demand on a computer screen. The long-sought boundary between the classical world we see and the quantum world we don't is then just our observation, and if everything is waves, the mystical idea of wave-particle duality can be abandoned.

How come the quantum?

Quantum theory explains Young's results as follows: every quantum entity has a *wave function* that spreads in space, whose power at any point is the *probability* it will exist there. This ghostly wave goes through both slits and interferes as it exits, but when observed suddenly "collapses", to become a thing in a fixed place, as if it had always been so. If detectors are in the slits, it collapses to one or the other with equal probability. If a screen is there, the wave interferes with itself as it leaves the slits, but on reaching the screen conveniently becomes a particle in one place. The mathematics doesn't say what this wave is that goes through both slits, nor why it suddenly shrinks to a point when observed. To this day, no-one can say what quantum waves are, prompting John Wheeler's question: "*How come the quantum*?"

To see how strange this logic is, suppose the *first photon* in a two slit experiment hits a screen at a certain point, becoming the first dot of what will *always* be an interference pattern. Now suppose the *first photon* of another experiment, with a detector blocking one slit, goes through the same open slit to hit the screen at the same point. This is now the first dot of what will *never* be an interference pattern. These different outcomes *must* exist in their first events, which physically are no different - in both cases a photon going though the same open slit hit at the same screen point. For these first photons, whether the slit they *didn't go through* was blocked decides the effect. If the photon *could* have gone through the other slit there is one result (interference), but if it *could not* there is another (no interference). How then can a *counterfactual event,* which could have happened but physically didn't, change physical reality? Yet this theory of imaginary waves that conveniently collapse when viewed works brilliantly. It is the most successful theory in the history of science, but it leaves two key issues unresolved:

1. *What are quantum waves?* What spreads through space as a wave?
2. *What is quantum collapse?* Why does the wave collapse to a point when viewed?

Until these questions are answered, quantum theory is not a theory but just a recipe without a rationale.

What are quantum waves?

As the Internet attests, information is easy to copy, which copying takes nothing from the original. One expects a virtual world to use copying for various reasons, including backup. The quantum no-cloning theorem argues that *we* cannot copy quantum states, because when *we* read quantum data we alter it irrevocably (Wootters & Zurek, 1982), but *the system* that creates a quantum process can by definition easily copy it.

If a photon is a program, a set of values to be set each node cycle, copying the process lets many processors share the task. This is proposed to occur by *instantiation of an entity class.* Instantiation is an object orientated systems (OOS) method by which screen "objects" dynamically inherit code from a common program source, e.g. screen buttons instantiating the same class look the same because they all run the same code. A class is like a *code blueprint,* from which information "objects" are not just created but also maintained, as any blueprint changes are immediately reflected in its instances.

A photon *entity class* separate from the grid could share its processing across grid nodes by instantiation, each node running the same process at a different phase. A photon wave would move not only forward but also spread out in all directions, which can occur by the same process of instantiation from a photon class blueprint. In the last paper, a grid node's neighbors were rotations around it representing all its directions in space. If each cycle every grid node shares it's processing with its neighbors, by Huygen's principle, a forward moving wave will ensue by reinforcement and interference. In this model, light is a wave, as Huygens proposed, but of processing not of physical acts.

This processing wave spreads outwards like a spherical ripple. By analogy, a pebble dropped on a pool gives two-dimensional ripples that weaken as they spread to larger circles (Figure 12). As the initial energy of the pebble drop disperses, it dilutes over larger circles, so apart from friction, the *total*

energy flux radiating outwards is the same for every ripple. Note that distributing class processing doesn't increase grid load - so even if a photon wave spread out over a galaxy, it would still use up only one photon's worth of grid processing.

Photon ripples that spread processing rather than physicality have no friction. They will expand in three dimensions not two, as spheres not circles, so the *total processing flux* radiating out across a sphere surface will be constant, i.e. decrease as an inverse square. While physical waves reduce their amplitude as they expand, processing waves just run slower over more nodes, essentially increasing their wavelength to cover the expanding surface by reducing their frequency in each processing node.

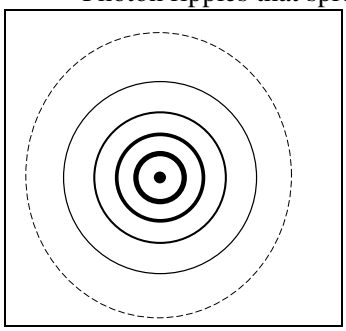


Figure 12. Pond ripples

That each photon, electron or quark is not a static thing but dynamic processing spreading as the grid refreshes could explain the distant action effects of fields. These spreading "images" would follow the principle of field combination, that field values add at a point[10], decrease as an inverse square and propagate at the speed of light (one grid node per cycle), as electrical, magnetic and gravitational fields do, e.g. if our sun suddenly disappeared, it would be eight minutes not just before the earth stopped receiving light but also before it ceased to feel the sun's gravity.

Existence divides

To Einstein a photon was a physical "thing" constrained in space, whose physical properties defined its later effects. It traveled a trajectory by one slit or the other to hit a screen, so its initial state should define where it hits. If this was unknown, then there must be "hidden variables":

"This is the fundamental problem: either quantum mechanics is incomplete and needs to be completed by a theory of hidden quantities, or it is complete and then the collapse of the wave function must be made physically plausible. This dilemma has not been solved until today, but on the contrary has become more and more critical."(Audretsch, 2004) p73

In this model, quantum mechanics is neither incomplete nor physically plausible, but a complete description of a non-physical reality. There are no hidden variables, just hidden instances.

If processing creates physicality, there is no reason it cannot duplicate and spread. It is only in a physical world of inherent "things" that this is untenable. Yet such a physical world, of inherent objects, is itself ultimately illogical. If a photon is a mini-object with hidden parts, these photon parts need still finer parts, and so on. If every physical object is built from smaller physical objects, how can it ever end? That physical objects always arise from other physical objects is like saying that the earth is a flat 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. The universe can no more be "objects all the way down" than it can be "turtles all the way down"[11]. The existential buck has to stop somewhere, and here the end of the line is information processing. While other physical things like molecules split into lesser physical things like atoms, light isn't formed from anything physical. Light, as the original grid activity, is the alpha of physical existence and the omega of physical decomposition.

If a photon spreads diminishing instances of itself outwards in all directions, which copy is *the* photon? The question assumes an objective thing, but here the photon is just a cyclic process setting its values on a network. This processing, distributed across many grid nodes, each a point in space, is its

[10] If charge 1 has electric field E_1 and charge 2 has electric field E_2 the electric field at any point $E = E_1 + E_2$

[11] In the apocryphal story, a physicist lecturing on the universe said it had no context. He was challenged by an 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, its turtles all the way down*".

existence. What "hits" Young's screen is the instantiation cloud of the photon entity class, which isn't "a photon" at all, but processing distributed across a network. This applies to all quantum entities, so to say an electron *has* a quantum wave function, is just the stubborn illusion of a physical world of inherent "things". In this model the electron *is* the quantum wave function.

Why then is a photon always detected at a point? A detector firing at one place only logically implies that a photon *interacts* at one place. That it always *existed* so is a conclusion we tack on to the facts, assuming that the world exists as an objective reality. Yet we only actually know that photons interact in one place, not that they always exist so. So when quantum mechanics says a photon *exists* as a probability wave in many places, then collapses to *interact* in one place, it doesn't contradict observation. The critics of quantum mechanics couldn't fault this logic because there is no fault. The next section explains why quantum entities that travel as spreading waves interact as singularities.

Quantum collapse

Quantum mechanics gives no reason why quantum waves suddenly "collapse" when observed:

"*After more than seven decades, no one understands how or even whether the collapse of a probability wave really happens*." (Greene, 2004), p119

In the model so far, the photon entity class endlessly spreads its processing out across the grid in a spherical fashion, which quantum mechanics formalizes as a three-dimensional probability wave. Quantum collapse is now proposed to occur when processing classes interact.

The photon class

If a photon is one basic grid operation divided, its instances can't combine to overload the grid, but different entity instances can. If a node already processing say a photographic plate also receives a photon processing request, it will overload, as its processing demands are more than it can provide. In our computing, if a processor experiences a fatal overload, it *reboots.* Or if a processor "hangs", we turn it off then back on again, which reboot restarts all processing from scratch. A reboot must reload *all* its processing because it loses all previous memory. So if a grid node has a fatal error, it makes sense for it to reboot, i.e. restart *all* its current processing, which it must reread from the entity classes involved.

An entity class normally divides its processing among many instances running on many nodes each cycle. A node reboot that demands all its processing will lock out other requests, as an entity class that delivers *all* its processing to a reboot cannot also maintain other instantiations that cycle. In a world of dynamic information they then immediately disappear, as an instance with no class support for one cycle has no basis to run next cycle. The collapse of the wave function is then just the inevitable disbanding of instances when the class supporting them is exclusively "locked", i.e. unavailable to other requests.

A node rereading the same processing will just overload again, so let it's *first* reboot action be to pass it's processing on to its neighbors, *then* do any processing it receives. This redistributes the processing overload in potentially in new ways, which are to us interaction outputs. If a node reboot re-reads and re-allocates the processing of two entity classes, it in effect merges them. In computing, when two entity classes merge both must first stop. Now while stopping an instance doesn't stop its class, stopping a class must stop its instances. If quantum collapse is when a class stops and restarts, it will be irreversible, because all previous processing is lost.

If entity classes "collide" when their instances overload the grid, giving a node reboot that stops, reallocates and restarts their processing, then the grid continuously annihilates and creates quantum entities, e.g. if two electrons bounce off each other *we assume* "the electrons" leaving the collision are those that entered it, but by the *indistinguishability principle* of quantum mechanics it is impossible to "mark" one electron from another. In this model, the electrons leaving are brand new ones, just off the quantum press, which again spread their processing until another reboot collapses them again.

Non-locality

Einstein felt that quantum collapse was absurd, as it implied faster than light travel. In his thought experiment a photon travels through a slit to hit a screen. Before it hits, the wave function exists at point A or B on the screen with some probability. After it hits, it is suddenly entirely at point A say, not point B. Now as the screen moves further away, the wave projection increases until eventually the A to B distance could be light years, but in quantum theory the collapse is still immediate. The moment point A "knows" it is the particle then B "knows" it is not, even if they are in different galaxies. The collapse decision is applied faster than the speed of light, which by special relativity is impossible by any known form of physical transmission.

The non-locality of quantum collapse is like a feather in New Zealand instantly tickling a physicist in New York – it contradicts physical reality. How can a change in one place connect to another *instantly* and *anywhere*? Quantum collapse as an exclusive entity class lock explains this. If a program stops, the screen pixels it controls must also stop, regardless of where they are onscreen. Program code is equidistant to every screen point. It needn't "go to" a screen node to alter it, but can do so directly, anywhere and immediately. As programs running pixels are not constrained by movement screen limits, so quantum collapse as a class effect is unaffected by special relativity restrictions.

The existence lottery

Yet it isn't so simple, as by the logic so far two electrons colliding are overlapping instance clouds that could overload at many nodes, i.e. many points of space[12]. What decides which node reboots?

In this model, an entity class serves its instances as a server does clients, by switching quickly between them. Network servers run much faster than clients do, so in the fraction of a second between a user's key presses, the server can service many other users. What to a network user is an immediate response, to a network server is millions or billions of cycles. If an entity class divides its attention among its instantiations like a network server, each node will actively access a class for only a small part of its cycle, giving two cases for an instance in a node reboot:

1. *The node is not accessing the entity class*, so it just waits. If the class doesn't respond that cycle the instance is dropped next cycle. An instance that overloads a node but can't access its entity class was a potential event that didn't happen.
2. *The node is accessing the entity class*, so can read all its processing that cycle, which denies all other instances access. An instance involved in a successful node reboot is a physical event.

Which node successfully reboots when two entity classes overload the grid depends on which first accesses both classes. So many instances overloading many grid nodes becomes a winner takes all lottery, where the first to lock in both source classes wins the prize of physically existing.

Now quantum mechanics derives probability of existence from Schrödinger's wave as follows: *amplitude is first added then squared*. Squaring an amplitude means a negative value has the same result as a positive one, but positive and negative adding at the same point give zero existence.

In this model, entity classes "collide" when their instance clouds overload many grid nodes and which reboot becomes a physical event depends on which node accesses the entity classes first. If a class operates like a network server, it will divide itself between nodes according to demand, i.e. the amount of processing requested. This is for a processing wave its power, which as for a physical wave, is its net amplitude squared. If the node first cancels positive and negative values, to avoid unneeded requests, the square of its net displacement is the processing power it needs that cycle. If a node needing more processing gets more class access per cycle, it is more likely to lock the class. So the square of a node's displacement is the probability it will lock a processing class on reboot, exactly as the square of a

[12] The next paper presents an electron as a single node overload. Physics also sees it as a "point particle".

quantum wave value predicts where in space a physical event occurs. Quantum waves as existence processing waves explains why they add as they do, why they collapse when they do, and why their power at each point predicts physical events. This model gives the same rules as quantum mechanics, but in addition explains why they are so.

Explaining Young's result

Table 1 interprets Feynman's outline of the basic principles of quantum mechanics for a single photon going through Young's slits to give a screen event (Feynman et al., 1977) p37-10 as a network protocol to resolve class collisions. In this view, diffraction arises when class instances overlap, physical existence arises when a node reboots and observation obstructing instances destroys interference even if nothing is physically "seen".

Table 1. Quantum mechanics as a network protocol

Quantum theory	*Network protocol*
1. Existence. The probability a photon *exists* is the absolute square of its complex probability amplitude value at any point in space[13]	*1. Interaction.* The probability a node reboot successfully locks a photon class is the amount of processing used, or its displacement squared
2. Interference. If a quantum event can occur in two alternate ways, their positive or negative probability amplitudes separately combine at every point, i.e. they interfere[14]	*2. Combination.* If entity instances can travel by alternate grid paths, their positive or negative amplitudes separately combine in every grid node, i.e. they interfere
3. Observation. Observing one path lets the other occur without interference, so the outcome probability is the simple sum of the alternatives, i.e. the interference is lost[15]	*3. Obstruction.* An obstacle on any path obstructs instances traveling that path, letting the alternate path deliver it's processing unchanged, i.e. the interference is lost

This model explains Young's results thus: a photon entity class distributes its processing existence through the grid that defines space, like ripples on a three-dimensional pond. These ripples pass through both Young's slits and interfere as they exit. On reaching the screen, they cause many grid nodes to overload and reboot, each requesting all the photon's processing. While the photon entity class can *instantiate* many times in transmission, it can only *interact* with another class in one processing place. The first node to lock the photon class is where it "hits". As class access varies with the processing requested, successful reboots follow the interference pattern the wave creates after the slits, even for one photon at a time. In quantum theory the wave function is a mathematical fiction, with no link to reality, but here it actually occurs, although we don't see it directly.

So a photon is a distributed processing cloud that only becomes a particle when all its processing is delivered to a node reboot, in the information transfer we call physical reality. If detectors are placed in both slits, a grid node in one or the other will successfully reboot with equal probability, destroying instances on the other path. If a detector is placed in one slit, it only fires half the time, but the obstacle still stops all instances on that path, which stops the diffraction effect.

Thus a processing wave can do what a physical wave cannot: go through both Young's slits at once, diffract with itself and then interact at a single screen point.

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[13] If U is the quantum wave amplitude, and P its probability, then $P = |U|^2$ for that channel.

[14] If U_1 and U_2 are the probability amplitudes of the two ways then the total amplitude $U = U_1 + U_2$. If $P = |U_1 + U_2|^2$, then $P = P_1 + P_2 + 2\sqrt{P_1P_2}\,\mathrm{Cos}(\theta)$ where the latter is the interference for phase difference θ.

[15] Now $P = P_1 + P_2$ with no interference term.

So if one asks if a photon went through both slits at once, the answer is yes. If one asks if it arrives at only one point on the screen, the answer is yes. If one asks if it is a spreading wave, the answer is yes. If one asks if it is a localized particle, the answer is yes *but only physically*. The photon as a wave of processing is only ever "a particle" when it interacts, which instances are collectively our physical world.

HOW LIGHT SPINS

Light as a fourth dimensional oscillation explains both why it polarizes in a plane and how it spins.

Adding a fourth dimension

Adding another dimension to a three-dimensional space doesn't just add another movement line, it turns *all of that space* into another dimension, e.g. a sphere of three dimensions gives a hyper-sphere, or sphere of spheres (Figure 13) [16]. While a three dimensional space only has three planes perpendicular to each other, a four dimension space has six planes *all perpendicular to each other*[17]. Adding just one dimension doubles the planar combinations, and the three extra planes are not just perpendicular to the three orthogonal planes of our space, but also to each other. *Quantum vibrations perpendicular to our space, can also be perpendicular to each other.* It is hard to grasp but mathematically defined, that a direction in quantum space is perpendicular to a plane in our space, not a point. A point in our space has three independent perpendiculars in quantum space, at right angels to the three orthogonal planes through it. So light can vibrate on the hyper-surface of space in three perpendicular directions.

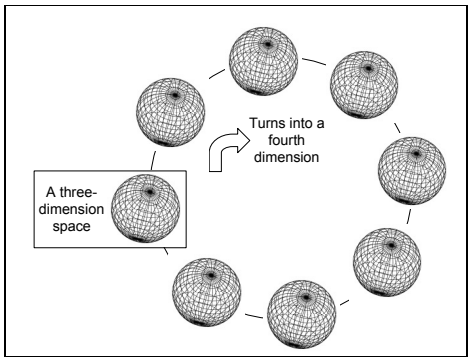

Figure 13. Adding a fourth dimension

The quantum projection

In physics a photon's electric field is a complex value rotating in an imaginary dimension, which in this model actually exists. The sine wave that light presents in our space (Figure 14a) arises when a transverse circle turns in quantum space but moves in our space (Figure 14b). This transverse circle is only transverse to a particular plane of our space, which is its polarization, i.e. *the polarization of light is the plane in our space perpendicular to its transverse processing in quantum space*. A photon moves in our space but vibrates outside it, at right angles to its polarization plane.

In this model, a polarized filter blocks polarized light in quantum space not physical space. If a vertically polarized photon vibrates at right angles to the vertical plane in quantum space, and a horizontally polarized one vibrates at right angles to the horizontal plane again in quantum space, both these vibrations are orthogonal not only to our space *but also to each other*. So vertically polarized light blocked by a horizontally polarized filter, can still pass right through a vertically polarized one.

Yet a light filter set at an angle lets photons *entirely* through some of the time. A lesser angle lets fewer photons through, but it is still all or nothing, e.g. an 81º filter lets 10% of photons through, which exit polarized at the filter angle. How can a polarized photon pass entirely through a filter that nearly blocks it entirely?

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[16] If physical space has dimensions (X,Y,Z), quantum space has dimensions (X,Y,Z,U), where U is a fourth, unseen dimension. Our space is just a surface in quantum space.

[17] Physical space with three dimensions X, Y and Z has three planes XY, XZ and YZ. Quantum space with an additional U dimension has three additional planes XU, YU and ZU.

The answer proposed here is that the photon *spins around its axis of movement* like a flying bullet. A quantum structure doesn't spin like a physical one, but it still needs a:

a. *Rotation axis.* Around which the spin occurs. This dimension doesn't change with the spin.

b. *Rotation plane.* In which the spin occurs. The structure's extents in these two dimensions swap values with the spin.

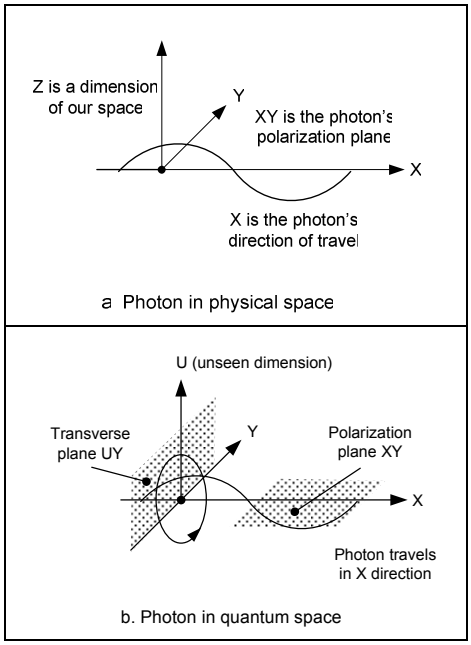

Figure 14 Photon polarization

For example, viewing a spinning propeller from the front shows its rotation plane. As each blade turns, its vertical extent becomes its horizontal one, i.e. the values swap. Viewing the propeller from the side shows its rotation axis and one rotation plane dimension. Now, a propeller blade seems to appear and disappear, as the spin swaps vertical and horizontal extents, but it is really turning into the unseen horizontal dimension.

Spin in four dimensions works the same way, with a rotation axis and a rotation plane, except now there are more ways to spin, e.g. a two dimensional structure has two planes to turn into, not just one, and a three dimensional structure can still spin into a fourth dimension.

In the model so far, a photon is a three-dimensional structure, that uses the dimensions X (of movement), Y (of polarization) and U (of existence), as shown in Figure 14b. This still leaves a free dimension (Z) in our space for it to spin into. A photon that *spins around its axis of movement into a plane our space*[18] turns into all the possible polarization planes of its movement axis (Figure 15).

In this model, a photon's vibration perpendicular to its polarization plane is its existence. By the previous, a quantum perpendicular to a vertical plane is at right angles to a quantum perpendicular to a horizontal one. So as a vertically polarized photon spins into a horizontal plane its quantum existence "disappears", as the propeller blade did when seen from the side. Its probability of existence will reduce as its spin angle increases, until at right angles to its polarization plane, it has zero extent[19]. Turning a polarized photon that exists in quantum space in our space is like turning a thin piece of paper until edge on it can't be seen at all.

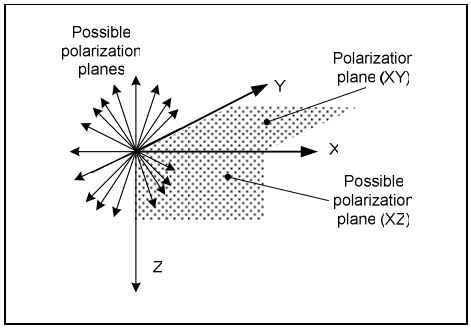

Figure 15. Polarization planes

If a photon spins *once per grid node cycle,* it in effect exists in every possible plane through its movement direction at once, with strength according to the angle. As already established, processing interactions are all or nothing, so if querying a grid node plane succeeds it will deliver *all* the photon's processing to that

[18] The transverse circle already turns around the X axis into the YU plane, but the photon could also turn into the YZ plane. This swaps its Y and Z values but leaves U and X unchanged. U remains perpendicular to XY and as Y and Z swap becomes invisible, as U has no extension orthogonal to the XZ plane.

[19] If U is the original existence it reduces as U.Cos(θ°) where θ° is the angle from in the original plane. So at a 90° angle it has no value as Cos(90°) = 0.

plane. The reboot then creates a new photon polarized in that plane. So a photon goes entirely through a filter or not for the same reason it hits a screen at one point not many.

Quantum spin

The spin of quantum particles has unusual properties:

"*… the spin of a fundamental particle has the curious feature that its* ***magnitude*** *always has the* ***same*** *value, although the direction of its spin axis can vary…*" (Penrose, 1994) p270

In classical spin, the earth spins on a fixed rotation axis into a fixed rotation plane (Figure 16). Measuring its spin on any axis gives a fraction of its total spin, and measuring spin on three orthogonal axes gives its total spin. However quantum spin is the same on *any axis* we measure, is always a fixed multiple of Planck's constant, can be in either direction, and once measured can't be re-measured on another axis. Indeed, quantum spin is so strange that when Pauli first proposed it he was not believed.

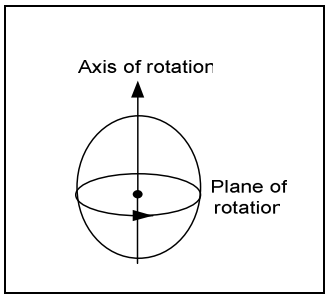

Figure 16. Classical spin

In the model so far, a photon is a three-dimensional quantum structure that spins in our space each grid cycle. Its transverse amplitude varies as it spins, by the nature of four dimensional space. This alters the probability of successfully measuring a photon spin in any plane, but not its effect, which is a node reboot that delivers all the photon's processing. Just as a photon can entirely pass a filter on an angle, so successfully measuring a photon's spin on any axis always gives *all* its spin. The amount of spin delivered is that of one transverse circle turn, which is Planck's constant expressed in radians[20].

A photon's spin can be randomly up or down (clockwise or anti-clockwise) if it divides its processing to spin both ways at once. These instances persist until a class interaction picks one with a particular spin to manifest. After that event, the processing is used up, so the same photon's spin cannot be re-measured on another axis. Imagine asking how a coin is spinning on a table if it is too fast to see. One can only know by stopping it, which event cannot be repeated, unless you re-spin the coin. Yet for photon spin, the coin isn't even in our space, it spins over the entire table, and it can spin in two ways at once. The next paper explains how more complex quantum structures like electrons "half-spin" in our physical world.

HOW LIGHT MOVES

Newton didn't accept Huygen's wave theory of light because:

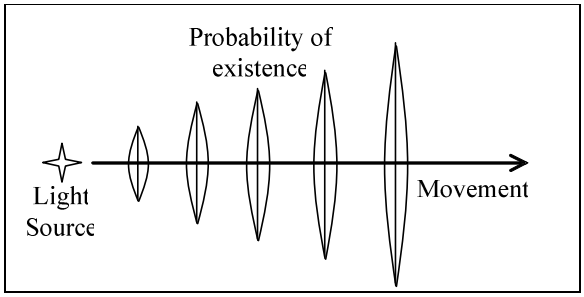

Figure 17. The probability of existence of light

"*For it seems impossible that any of those motions … can be propagated in straight lines without the like spreading every way into the shadowed medium on which they border.*" (Bolles, 1999) p192

If light waves spread out, he argued, why does light go in straight lines through optical devices?

The photon wave

We know sound is a wave because it bends around corners, allowing us to hear people talking in the next room. In 1660 Grimaldi first showed that light also spreads out, but much less as it has a much

[20] Spin is actually expressed in Plank's reduced constant of ħ (h-bar) = h/2π (in angular radians).

shorter wavelength. Figure 17 shows how a photon probability wave might vary in power along its line of travel, where the photon is more likely to exist at the thicker sections. Only the probability maxima are a straight line so when a photon is detected by a series of screens at different distances the hits are not a perfect straight line but randomly distributed about it (Figure 18). A particle theory would need photons to travel in a zigzag path to explain this. Yet if a photon is a spreading wave that only travels in a straight line *on average,* why doesn't it *sometimes* "bend into the shadows", to let us see a torch beam from the side? A light wave should have a wake behind it, like the turbulence of a high speed bullet. How can an *average* maximum probability line become a "ray" of light?

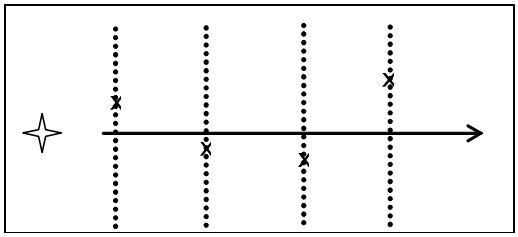

Figure 18. Detection of a "ray" of light

Principle of least action

Behind this problem lies an even deeper one that has puzzled thinkers for centuries. Hero of Alexandria first observed that light always takes the path of shortest distance between two points, raising the question how it knows which direction will give the shortest path?

In 1662 Fermat amended this to be the path of least time, as when light refracts it takes the fastest not the shortest path. Refraction is light changing direction as it enters a transparent medium like water where it travels slower (Figure 19), illustrating Fermat's law of least time. Imagine the photon as a life guard trying to save a drowning swimmer as soon as possible. Is the dotted straight line shown the quickest path to the swimmer? If the lifeguard runs faster than he or she swims, it is quicker to run further down the beach then swim a shorter distance, as shown by the solid line. In Figure 19, the dotted line is the shortest path but the solid line is the fastest. When light refracts it bends to take the solid path of least time. In wave terms, the wave part that hits the boundary first slows down first to bend the wave front direction, so refraction is just light traveling in a "straight" line adjusted for speed. In 1752 Maupertuis developed this into a general principle that:

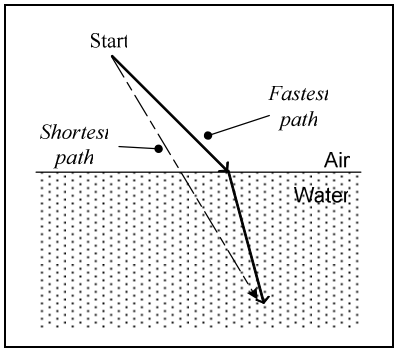

Figure 19. Wave refraction

"*The quantity of action necessary to cause any change in Nature always is the smallest possible*".

This *principle of least action,* that light always takes the best path, was developed mathematically by Euler, Leibnitz, Lagrange, Hamilton and others, sparking a furious philosophical debate on whether we live in "the best of all possible worlds". Despite Voltaire's ridicule, how light finds the path of least action remains a mystery today, e.g. light bouncing off the mirror in Figure 20 could take any of the dotted paths shown but by the principles of optics always takes the solid line shortest path. How does it do this? As the photon moves forward in time to trace out a complex path, how can it *in advance* know at each stage the shortest route direction? To say that it chooses a path *so that* the final action is the least gets causality backwards. As Feynman says:

"*Does it 'smell' the neighboring paths to find out if they have more action*?" (Feynman et al., 1977) p19-9

That a photon, with no known internal mechanisms, always finds the fastest route to any target, for any media combination, for any path complexity, for any number of alternate paths and inclusive of relativistic effects, is nothing short of miraculous.

Taking every path

Feynman suggested that photons actually do check out all possible paths, because when they can't, all paths become equal (Feynman et al., 1977) p26-7, but the conventions of the day prevented him from proposing the physically impossible. Yet his *sum over histories* method, which *supposes* that light

goes from A to B by all possible paths then chooses the one with the least action integral, exactly predicts how light travels. In the Copenhagen view, this is just a formula disconnected from reality, but in this model it is what photon instances actually do:

Photon instances travel all available paths of the underlying grid architecture.

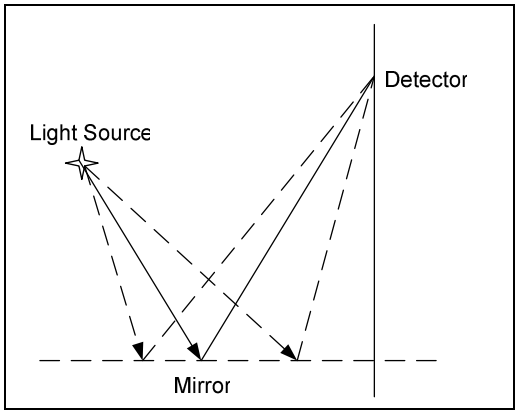

Figure 20. Principle of least action

If photon instances travel all possible paths, those that happen to take the fastest route are likely to trigger a successful grid node reboot first. This event then destroys all other instances, like a clever magician removing the evidence of how a trick is done. When an instance *becomes* "physical reality" so does its path, which just so happens to be the fastest. The policy of always leaving decisions until the last moment is known in computing as *just in time processing (JIT)*. If photon instances practice Feynman's theory, and actually take all paths, a first come first observed principle will always select the fastest one.

Indeed, how else could a law of least action arise? A photon *cannot* know in advance the fastest route to an unspecified destination. So rather than calculating a route *before* it leaves, it just spreads out to take them all, then lets the system holistically choose "physical reality" *later*. Taking all routes may seem inefficient, but in a virtual world calculating a path and taking it are the same processing effort. To pick the path of least action a system must calculate all the paths anyway, so taking them all then picking the fastest avoids double handling. We think we see all there is, but in this model the physical world is just the end product of a great deal of unseen quantum processing.

If entity instances spread by all possible grid channels then all that can occur does occur – it just doesn't necessarily appear physically. In this "evolutionary physics", quantum processing calculates all the options and physical reality takes the best and drops the rest. The physical principle of least action implies a quantum principle of all action that: *everything that could occur in physical reality does occur in quantum reality*[21]. If physical reality is selected from many unseen but lawful quantum options, then if this isn't the best of all possible worlds, it isn't for lack of trying.

Retrospective action

Photons travel at about a foot per nanosecond, which allows a *delayed choice* two slit experiment, where detectors are turned on *after* the photon passes the slits. Two detection options are set up. The first is the usual screen that gives an interference pattern, but the screen can also be quickly removed to reveal two telescopes that focus on only one slit or the other (Figure 21).

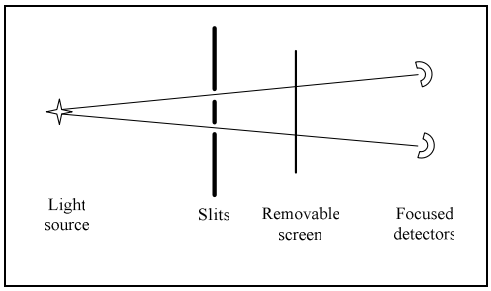

Figure 21. Delayed choice experiment

The experiment turns on *either* screen or telescopes *after* the photon passes the slits. If the screen is turned on, it gives interference, showing the photon traveled both paths. If the screen is removed and the telescopes turned on, only one or the other fires, showing the photon traveled by one slit or another. Detectors turned on *after* the photon traveled a path decided the path taken:

[21] Also stated by Feynman as whatever is not explicitly forbidden must happen and by Gellman as the quantum totalitarian principle.

"*Its as if a consistent and definite history becomes manifest only after the future to which it leads has been settled.*" (Greene, 2004) p189

An observation made *after* a photon travels deciding a path it took *before* it was observed is backwards causality – the future affecting the past - and the distances involved are irrelevant. A photon could travel a billion years from a distant star, then decide when it arrives at earth if it "actually" came here by galaxy A or galaxy B. As Wheeler observes:

"*To the extent that it {a photon} forms part of what we call reality… we have to say that we ourselves have an undeniable part in shaping what we have always called the past.*" (Davies & Brown, 1999) p67

If a photon's path depends on an observation made after it travelled, then the arrow of causality fails, and with it much of physics. The alternative proposed here is that photon instances travel all paths, and "physical reality" only arises when one of them is selected to interact with a detector. Now, adding or removing detectors while a photon is en-route isn't a problem, as physical reality only exists at the detector. The photon is processing that divides itself into all possible paths until the successful grid node reboot we call observation occurs. This makes one instance "the photon" and its path "the path the photon took". If the photon *doesn't physically exist* until it arrives, neither does the path it took. That a photon's physical path isn't decided until it arrives isn't time reversal at all, as *all other possible paths were also traveled.*

In an objective reality, delayed choice experiments mean that time flowed backwards, but in a virtual reality there is no time reversal at all. This model leaves the causality of the world intact, as if physical reality is chosen after all paths are travelled, delayed choice experiments no longer imply retrospective action.

Non-physical detection

In quantum mechanics an object on a path not traveled can be detected using the Mach-Zehnder interferometer, a setup originally designed by John Wheeler (Figure 22). A light source first shines on a beam splitter, which sends half its light down *path 1* and half down *path 2*. Path 1 has a mirror pointing to detector 1, and path 2 has a mirror pointing to detector 2. At this point, light then travels both paths equally and each detector fires half the time. Now add a second beam splitter where the two paths cross, to again send half its light to each detector. With this splitter in place, light is only detected at detector 1, never at detector 2. Sending *a single photon at a time* through the system has the same effect - detector 1 records it but detector 2 doesn't respond at all.

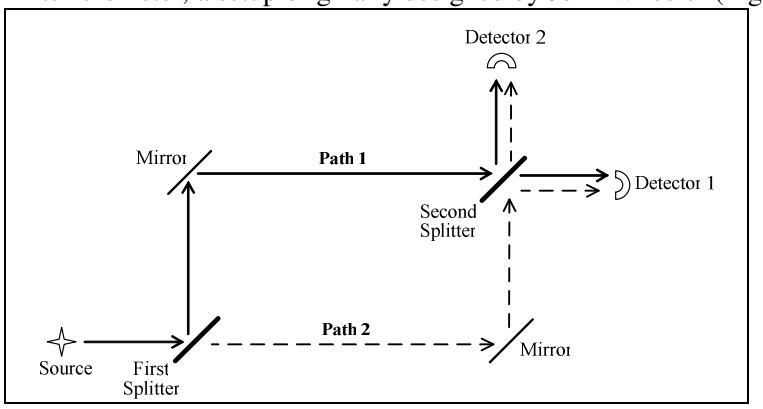

Figure 22. The Mach-Zehnder interferometer

Quantum mechanics explains this using quantum states that the Copenhagen convention says aren't real. As these evolve down the two paths, each mirror or splitter turn delays their phase by one quarter. Both paths to detector 1 have two turns, so states traveling them are phase shifted by the same amount. However path 1 to detector 2 has three turns, while path 2 has only one. Two paths phase shifted this way cancel out, so nothing is seen at detector 2.

Remarkably, this setup can register an object without physically touching it (Audretsch, 2004) p29. Suppose path 2 has a bomb so sensitive that even a single photon sets it off. Looking directly to see if it is there will explode it, but if a bomb blocks path 2 *some* photons hit detector 2 without exploding the bomb, which *never* happens if path 2 is clear. This *proves* a bomb is blocking the path, though no light has touched it physically.

The result has been verified experimentally, though not of course with bombs (Kwiat, Weinfurter, Herzog, Zeilinger, & Kasevich, 1995). Light shone through a Mach-Zehnder interferometer with two clear paths only ever fires one detector. If a receptor sensitive to *any* light is put on a path, then a quarter of the time the other detector also fires. This occurs *only* with a receptor on that path, yet that receptor didn't physically register anything.

In this model, the mathematical states of quantum mechanics actually occur, so photon entity class instances travel all four paths to both detectors with equal probability (Table 2). If both paths are clear, the instances going to detector 2 by both paths interfere, so it never fires. If there is a bomb on path 2,

Path	**Existence Probability**	**Observation**	
		No Bomb	**Bomb (path 2)**
Detector 1 by path 1	25%	Detector 1 fires	Detector 1 fires
Detector 1 by path 2	25%	Detector 1 fires	Blows bomb
Detector 2 by path 1	25%	Light by these two paths is out of phase and cancels out	Detector 2 fires**
Detector 2 by path 2	25%		Blows bomb

*Table 2. Non-physical detection (see **)*

half the time instances traveling on path 2 set it off. The rest of the time the photon exists in instances traveling the other path to the final splitter, which sends half of them to detector 2. Only if a bomb blocks path 2 can instances reach the normally quiet detector 2 with no interference and interact, showing a bomb is there.

Knowing a bomb is there when no physical photon can touch it is *logically impossible* in an objectively real world, but in our world *non-physical detection* is a proven effect. There is no doubt that we can detect a bomb sensitive to a single photon without setting it off. A *counterfactual event*, a detector that could have fired but didn't, on a path the photon didn't travel, can alter physical outcomes. Whether we call such events quantum states or instantiations, the inescapable conclusion is that a non-physical quantum reality exists.

Creating choice

So the answer to how light, the simplest of all things, always finds the best path to any destination is simple – it doesn't. It takes all possible paths and lets the system holistically pick its physical arrival event. Light as processing that continuously spreads by instantiation can re-spawn from any instance, with quantum collapse the necessary garbage collection of other instances. If the photon spreads until it overloads the grid, then restarts anew at a reboot point, nothing is ever lost and nothing can go wrong. Equally, all the processing bills of this system are paid in advance, as the null processing of empty space is pre-allocated to accommodate anything up to a black hole. It is a fail-safe system, where all that can be done is done, all that can exist does exist, and all the processing needed is already running. The quantum machine inexorably grinds every option, yet our world is random at the core. If it is a machine then it is one with:

"*…roulettes for wheels and dice for gears.*" (Walker, 2000) p87

We live in a world of quantum uncertainty not mechanical certainty, as repeatedly querying a physical state gives a different answer each time. Knowing everything physically knowable, we still can't predict when an atom will emit a photon, i.e. it is random. A random choice *is still a choice,* just

one that no physical world rules limit and no preceding physical events cause. If quantum mechanics is mechanical but quantum collapse is random, where then are the latter choices made?

If the physical world is a self-sufficient, objective reality, then no choice can arise outside it, but in this model the processing source can create quantum choice, like random number generation in a computer game. Here our physical world is not an objective reality that one sees from above as a bird does. We see our world as a frog does, from the ground level, and our frogs-eye view of the world is limited and biased. In system terms we are "embedded observers", unable to see relativistic changes of time or space because they change us too. When we "observe" a photon, objectively it also "observes" us, i.e. this world always looks back when observed. If all observation is reciprocal, and everything is quantum waves, then our observation is quantum waves mutually interacting.

Given no basis to differentiate observer and observed, random choices arise when quantum reality interacts with itself. It isn't *human* observation that collapses quantum waves, but *any* observation, i.e. interaction. The uniqueness of observation in quantum mechanics lies not in us as special observers but in the special act of a system observing itself. A perfect reality *cannot* give an indeterminate outcome, but what happens if such a reality *interacts with itself?* Is the result a lawful world with choice, with our universe exhibit A?

Yet that electrons can *randomly* act, regardless of their physical past, doesn't prove that people can *freely* act, regardless of their physical past. Quantum randomness doesn't prove free choice, but it does prove that the world isn't just a physical machine, which lets free choice dodge the logical bullet of determinism. Unlike mechanistic theories, the virtual conjecture doesn't deny the idea of social accountability, that people choose their actions, or at least have the option to do so. Randomness could be just a default choice, used to allow evolution when nothing better is available, e.g. *conscious choice*. Given an originating reality behind the physical world, conscious choice and random choice could both come from the same source, except that one would occur knowingly and the other unknowingly.

In this model, the physical world is a virtual reality arising when an original reality observed itself. In these terms, while the physical may be merely virtual, the observer is not. So while conscious choice can't emerge from a virtuality, it could emerge from what creates it. Consciousness then arises not from the observed physical substrate, which is virtual, but from the observing substrate, which is our sense of being or "I". Such awareness of self is illustrated by Piaget's theory, where cognitive growth occurs as higher parts of the brain learn to observe lower parts, something our most powerful computers fail dismally at (Whitworth, 2009). If this model is correct, consciousness is possible in us only because it is present in all things, which connection has been formally put as Conway's Strong Free Will Theorem, that if humans have free choice then so do quantum particles (Conway & Koch, 2006). Consciousness then arises by tapping a greater consciousness, rather than our own efforts, as has been the view of many thinkers, including Eckhart, Rumi, Lao-tse, Hui-Neng and Shankara to mention a few. This idea will be considered in more detail in a later paper.

HOW LIGHT MANIFESTS

Modern physics challenges our ideas of how physical reality manifests.

Superposition

Mathematicians can solve an equation to give solutions that satisfy its conditions. Solving the quantum wave equation also gives solutions - "snapshots" of possible outcomes each with an associated probability. These solutions evolve dynamically over time, forming at each moment an *orthogonal ensemble,* only one of which can physically occur.

This mathematics has an unusual feature: if any two states are solutions, so is their linear combination[22]. It is in this *superposition state* that one photon goes through both Young's slits at once. While single state solutions match familiar physical world events, superposition states never physically occur. Yet these combination states are central to the mysterious effectiveness of quantum mechanics, as they act differently from their components.

For example, ammonia molecules have a pyramid shape, with one nitrogen atom at the apex (1) and three hydrogen atoms (2,3,4) as the base (Figure 23), so can manifest in the right or left handed forms shown (Feynman et al., 1977) III, p9-1. To turn a right-handed molecule into a left-handed one, the nitrogen atom would have to pass through the pyramid base, which is physically impossible, but in quantum mechanics, if two states are valid so are both at once. Even though it can't oscillate between these states, as it is physically impossible, observing an ammonia molecule can find it left handed one moment then right handed the next, by chance. It exists probabilistically in physically incompatible ways at the same time. This superposition is not just ignorance of a hidden state. Seeing wave function superposition as the combination of classical states is to misunderstand it, e.g. superposed electric currents can flow both ways round a superconducting ring at the same time, even though physically such currents would cancel each other out (Cho, 2000).

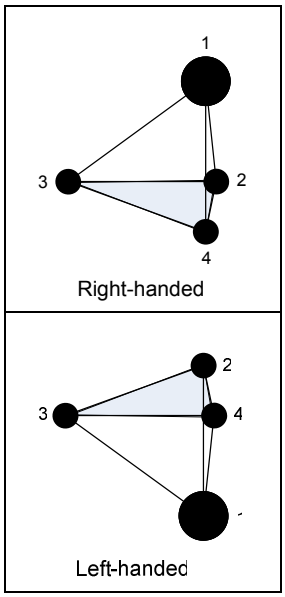

Figure 23. Ammonia molecule states

In this model, superposition occurs when a quantum entity class spreads its processing existence down all possible grid channels. In doing so, it doesn't physically exist until a grid overload occurs. The instances that share its processing can't appear physically, as they cant overload the grid, so photon instances can spin both clockwise and anticlockwise at once. This contradicts our idea of objective reality, but in the quantum world it is just business as usual.

Schrödinger's cat

Schrödinger found quantum superposition so strange he tried to illustrate its absurdity by a thought experiment in which he imagined his cat in a box where photons randomly radiate onto a detector that releases a deadly poison. In quantum theory, these photons both exist and don't exist until observed. If photon plus detector are also a quantum system, they are also superposed in both detected and undetected states. By the same logic, the detector is in turn observed by the poison release system, which also both fires and doesn't fire. In this infinite observer regress, the cat is in an alive-dead superposition until Schrödinger opens the box to check it out.

So if a photon can both exist and not exist, can Schrödinger's cat be both alive and dead? Or if cats can't be alive and dead at the same time, how can photons both exist and not exist? Or if photons can superpose but cats can't, as quantum entities merge into classical entities, when does the superposition stop? Wigner developed Von Neumann's idea that human "consciousness"[23] triggers the wave function collapse, but if we are observation central, how did the universe manage before we came?

In this model, *any* interaction that merges entity classes collapses the wave function, so superposition states don't cumulate past the first interaction. A quantum entity's uncertainty stops the first time it interacts with another, when all its instances stop immediately. We may not know if the cat is alive or dead, but *the cat does*.

---

[22] If Ψ_1 and Ψ_2 are state solutions of Schrödinger's equation then $(\Psi_1 + \Psi_2)$ is also a valid solution

[23] In this use the term "consciousness" is assumed to be an inevitable property of all people, while this model suggests it is an awareness that may arise and disappear at different times.

Entanglement

Bell used Einstein's reductio ad absurdum thought experiment (Einstein, Podolsky, & Rosen, 1935) to devise *Bell's inequality.* This allowed a definitive test of quantum theory's predictions against those of an objectively real world, for the case of entangled photons.

Photons entangle when each acts randomly but their combination does not, e.g. if a Caesium atom releases photons in opposite directions, quantum mechanics assigns *the pair* the original system's spin of zero. So if one photon is measured spin up the other must be spin down. Since each photon's spin is random, if one is randomly up how does the other immediately know it must be down, at any distance? In quantum mechanics, entangled photons are a single combination state, even if light years apart. To Einstein, that measuring one photon's spin instantly defines another's spin anywhere in the universe was "*spooky action at a distance*".

Testing Bell's inequality was one of the most careful experiments ever done, as befits the ultimate test of the nature of our reality. Quantum theory was proved right again when measuring one of two entangled photons affected another many miles away, faster than the speed of light allowed (Aspect, Grangier, & Roger, 1982), proving beyond doubt that there was no physical signaling:

"*In short, the experimental verdict is in: the weirdness of the quantum world is real, whether we like it or not.*" (Tegmark & J. A. Wheeler, 2001) p4

Entangled states, now common in physics and quantum computation (Salart, Baas, Branciard, Gisin, & H., 2008), are impossible in an objective reality, but in a virtual reality, they can arise if entity classes co-process, as classes in object orientated systems (OOS) exchange system level messages.

Suppose a Caesium atom produces two photons traveling in different directions. The initial system has a total spin of zero, so if each photon's spin is random then both could be spin up, or both spin down, i.e. not a total spin of zero. In this model, while separate entity classes can't ensure a spin zero outcome, *co-processing entity classes can*. As already proposed, a photon class services its spin-up and spin-down instances equally, so a reboot can request all its processing for either with equal probability. Co-processing classes can maintain a spin zero total by continuously ensuring that as one class services one spin the other services the opposite spin (Figure 24).

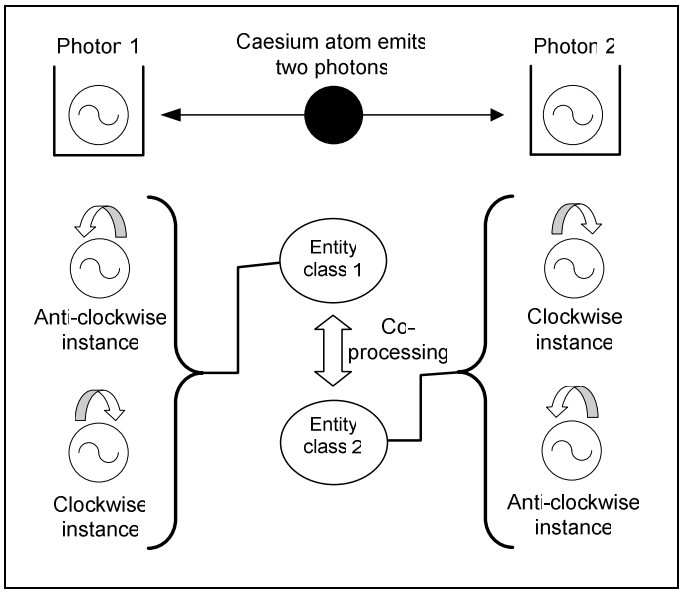

Figure 24. Entanglement as co-processing

In co-processing, if either process stops, both do. So if one class stops to deliver all its processing to a random node overload of say spin up, the other class will stop and restart its current instance, which will be spin down. If either class interacts, both will stop immediately on opposite spin instances because they are continuously servicing opposite spin instances.

Entanglement then is a shared quantum collapse, when one of two co-processing classes interacts. Its effects are then non-local for the same reason quantum collapse is, that class effects ignore grid transfer limits. No matter how far apart entangled photons travel they are connected at their class source. Bose-Einstein condensates could arise when more than two entity classes co-process.

The physical reality interface

The holographic principle is that: *Everything physically knowable about a volume of space can be encoded on a surface surrounding it* (Bekenstein, 2003).

We deduce depth when light traveling different distances to us arrives slightly out of phase. While normal flat photos just store light intensity, holograms also record the light phase differences that encode depth, so flat holograms on credit cards can encode three-dimensional images. This is done by splitting laser light and letting the half that shines on the object interfere with a matched reference half to create the holographic pattern (Figure 25). Light later shone on that pattern recreates the original 3D image.

Common sense tells us that the information in a space depends on its volume, e.g. the number of memory chips that can be added to space depends on volume, but if the chips are made smaller and smaller, to increase the information contained, they eventually form a black hole, whose entropy (information) depends on its surface area not its volume. So the holographic principle is maintained by the behavior of black holes (Bekenstein, 2003). While the universe may seem to have three dimensions, all the information we get about it comes to us across a two dimensional surface.

That *any* physical object can be stored as a two-dimensional interference pattern, the holographic principle, arises inevitably from this model, as physical objects are information transfers. Light moving in three dimensions needs an observation dimension for the information transfer of physical reality to flow across. This model *requires* the holographic principle to be true because a four dimensional hyper-space needs one degree of freedom to express existence and one to transmit it across, leaving only two to carry the information that represents physical reality to us. Physical reality as an information transfer in three-dimensional space must occur across a two-dimensional surface. Equally each node of the grid can only receive world information from the nodes around it, which by the previous paper arise from two orthogonal rotations. The physical world registered at any point can be painted on the surface of a sphere around it because that is in fact how it arrives.

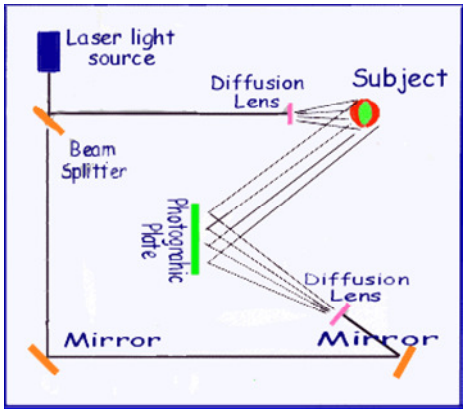

Figure 25. Producing a hologram[24]

The holographic principle describes how we receive the world, but how does the world exist in itself? Traditionally, the world "out there" is just as we see it, an objective physical reality. The simpler view taken here is that the *physical* world is "nothing but screen", and out there is something else entirely. Observation then is not a transparent view of a static world, but information from a firewall that censors what we know and can know. If the world is a hologram, it is not one that we can walk around in like a detached observer, nor like the Star Trek holodeck that one can enter or exit at will. Indeed, even if we wanted to leave, if we *are* the hologram image, where could we go?

REDEFINING REALITY

This model questions the traditional idea that reality is the physical world we register.

The measurement paradox

If observation collapses the wave function, and science knows the world by observation, how can science study quantum waves that are by definition unobservable, now and forever? The measurement

[24] From http://www.mikecrowson.co.uk/Touching.html

paradox is that quantum mechanics denies science in principle the opportunity to observe it, as every attempt shows only a "thing" in one place:

"*The full quantum wave function of an electron itself is not directly observable…*" (Lederman & Hill, 2004) p240

Logical positivism, the statement that only observables and logicals exist in science, implies that only "*…what impinges on us directly is real*." (Mermin, 2009) p9. If unobservable quantum states *can't be* real the formulae of quantum theory *must be* merely convenient fictions. If logical positivism defines science, then quantum theory is not scientific, as it references the unobserved. Conversely, if quantum theory is science, then logical positivism is not really a necessary condition for it. To this day, this issue is unresolved:

"*The history of the quantum measurement paradox is fascinating. There is still no general agreement on the matter even after eighty years of heated debate*." (Laughlin, 2005) p49.

In this theory, logical positivism is an opinion on the nature of reality masquerading as an axiom of science. Indeed, the logical conclusion of positivism, that quantum states are unreal, is itself illogical:

"*Can something that affects real events … itself be unreal?*" (Zeh, 2004) p4.

Science needn't be *constituted* of observables, as logical positivism holds, but only *predict* them, as quantum mechanics does. Quantum theory is then entirely scientific and positivist extremism is not.

The straw man positivists like to scapegoat is *reifying quantum states* - taking quantum states as physically real - but this model's *de-reifying of physicality* isn't so easily dismissed. If quantum states are the prime reality, they don't need to be made physical to be real, as physicality is just an appearance they create. Requiring quantum states to be physical is like requiring a TV actor to adopt their onscreen persona when meeting them.

That *all reality must be the reality I know* is a type of narcissism. What, exactly, is the case that the physical world is all there is? If one asks for proof, or even a good reason, why quantum waves *cannot* be real, positivism falls like the logical house of cards it is. In this model, quantum mechanics describes the camera we use to take physical reality pictures, so it can no more photograph itself than a finger can point to itself. Science may need to upgrade its traditional *observables* camera to a more sensitive *conceivables* one to accommodate quantum mechanics.

Many worlds theory

That quantum choices don't arise from prior world events is an *uncaused cause* that threatens the foundations of physicalism. In 1957 Everett suggested the many worlds answer, that every quantum event spawns a new universe. If every quantum choice spawns alternate realities, no choice is ever actually made, so there is no quantum collapse. Everett solved the problem of quantum choice by inventing a multiverse machine around the quantum ghost, eliminating choice entirely.

While initially ignored, physicists today prefer it three to one over the Copenhagen view (Tegmark & J. A. Wheeler, 2001) p6. Yet its overheads are staggering. Billions of galaxies of photons, electrons and quarks each making billions of choices a second for billions of years means the:

"*… universe of universes would be piling up at rates that transcend all concepts of infinitude.*" (Walker, 2000) p107.

This theory offends Occam's razor, as it assumes more than it explains. Deutsch's attempt to rescue it by letting a finite number of universes "repartition" at each choice just recovers the original problem, as what decides which universes are merged or dropped? The clockwork multiverse just reincarnates the clockwork universe that quantum theory demolished a century ago into a fashionable zombie theory that cant be falsified. Why should an immense multi-verse, like a doting parent with a video-camera,

copy everything our universe *might* do? The *ex post facto* argument of many worlds illustrates the lengths some will go to deny choice in our world.

In contrast, choice is central to this model, as without it there is no information and no processing. It proposes a dynamic universe of constant choice not a static meta-verse of automatic machinery.

The quantum paradox

A review of ten "myths" of quantum mechanics traces them all back to one core problem:

"*Thus, I conclude that the main reason for the existence of myths in QM {quantum mechanics} is the fact that QM does not give a clear answer to the question of what, if anything, objective reality is.*" (Nikoli´, 2008) p43

Our tradition of objective reality began with Aristotle's view that:

"*… the world consists of a multitude of single things (substances), each of them characterized by intrinsic properties …*" (Audretsch, 2004) p274

This two thousand year old view, of "things" existing in locations that limit their effects (locality), with intrinsic properties independent of observation (realism), still dominates thinking today. Officially quantum mechanics doesn't challenge this reality view, but actually its "things" are probability waves that continually appear and disappear. Since quantum mechanics is always right, and Bell's experiment is the proof that leaves no doubt, then:

"*… why not simply accept the reality of the wave function?* (Zeh, 2004) p8

It is not so easy, as if the wave function is a reality then so are quantum state changes:

"*Thus, if we are to take* ψ[25] *as providing a picture of reality, then we must take these jumps as physically real occurrences too…*" (Penrose, 1994) p331

Schrödinger initially tried to treat his wave states as a physical property, like say an electron's charge, but didn't work, and other attempts since then to reify quantum states have also failed (Mermin, 2009). When Pauli and Born interpreted the quantum wave as a probability of existence amplitude, it ceased to be something physical at all:

"*For the first time in physics, we have an equation that allows us to describe the behavior of objects in the universe with astounding accuracy, but for which one of the mathematical objects of the theory, the quantum field* ψ*, apparently does not correspond to any known physical quantity.*" (Oerter, 2006) p89

Quantum states can disappear at will, so don't have the permanent nature of physical matter. Their entangled effects ignore speed of light limits, so they don't follow the rules of physical movement. Superposed states exist simultaneously in physically contradictory ways, so they don't clash like matter. Quantum waves spread forever at light speed, so an unobserved electron could exist throughout a galaxy, which is physically impossible. In conclusion, *quantum states are in every way physically unreal*, i.e. lacking physical properties. As Barbour says of quantum collapse:

"*How can something real disappear instantaneously?*" (Barbour, 1999) p200

This then leads to the quantum paradox, *that quantum unreality creates physical reality,* or as Penrose says:

"*How, indeed, can real objects be constituted from unreal components?*" (Penrose, 1994) p313

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[25] ψ is the quantum wave function.

Paradoxes arise when impossible assumptions are accepted, e.g. Figure 26 shows two square prongs but looking down shows three circular ones. The paradox occurs when we assume a line can bound both a square and circular prong at once, which is impossible. Equally impossible is that quantum and physical worlds co-exist, as the Copenhagen interpretation claims. The quantum paradox arises when we suppose separate realities to simultaneously exist, which is impossible. Either the quantum world is somehow physical or the physical world is somehow a quantum derivative. For over fifty years the first option, of reifying the quantum wave, has been tried unsuccessfully. It is time to consider the second option, that the physical world is a quantum effect. This model makes that possible, given only that the physical world is a quantum processing output.

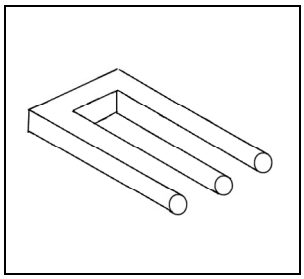

Figure 26. A paradox

Non-physical realism

The Bell's experiment logic was based on the following three apparently self-evident axioms of how the world behaves (D'Espagnat, 1979)*:*

1. *Physical realism*. That "*there is some physical reality whose existence is independent of human observers.*" (D'Espagnat, 1979) p158
2. *Einstein locality*. That no influence of any kind can travel faster than the speed of light.
3. *Logical induction*. That induction is a valid mode of reasoning.

Given the experiment results, one of these assumptions *must be wrong*. If realism and induction are true, then Einstein locality must be wrong. If locality and induction are true, then a real world can't exist independent of our observation of it. Physics has still not yet resolved this problem:

"*According to quantum theory, quantum correlations violating Bell's inequalities merely happen, somehow from outside space-time, in the sense that there is no story in space-time that can describe their occurrence*:" (Salart et al., 2008) p1

The resolution proposed here is to remove the word "physical" from the definition of realism and put it into the definition of locality. Realism then becomes *that there is a ~~physical~~ reality whose existence is independent of human observers* and locality becomes *that no physical influence of any kind can propagate faster than the speed of light.* This lets a non-physical quantum reality exist and limits Einstein's logic to physical objects. This model drops physical realism but keeps realism, and drops universal locality but keeps physical locality. Doing this resolves the quantum paradox, but at the cost of shifting the locus of reality from the physical world to the quantum world.

Observation creates physical reality

In quantum theory, *physical events like a photon hitting a screen are created by their observation*. This makes no sense for an objective physical reality that exists in and of itself, as then we create the objective world by looking at it! No other conclusion is possible, but as Einstein said, surely the moon still exists when no-one sees it? For over half a century, physics has faced this version of the quantum paradox as it has all the others, like a deer in headlights.

The problem arises when *realism* is equated to *physical realism*:

"*If one adopts a realistic view of science, then one holds that there is a true and unique structure to the physical universe which scientists discover rather than invent.*" (Barrow, 2007) p124

The word "physical" is assumed intrinsic to the definition, but it is just as effective without it:

"*If one adopts a realistic view of science, then one holds that there is a true and unique structure to the universe which scientists discover rather than invent.*"

In this pure realism, science discovered rather than invented quantum states, while physical realism is just a positivist assumption. This model has a real world apart from us, but it is an unseen quantum world not the physical world we see. As Kant observed, we don't see things *as they are in themselves* (Kant, 2002) p392, i.e. as quantum waves. If the physical world is a quantum output, and the quantum world is its containing reality, then observation initiating that output no longer contradicts realism. Physical reality is just a view produced when the quantum database is queried, so naturally we create it, exactly as quantum theory says. It is not the formulation of quantum mechanics that is fictional, but our idea of the physical world as an objective reality.

The unseen world

A common response to virtualism is to demand proof, and rightly so, yet objective reality theory is held without proof. Given no proof that the physical world self-exists, and evidence that it doesn't, why is objective reality theory unchallenged? Given two unproved statements, why give one a free pass but obstruct the other by all means possible? One reason is our bias:

"*Observers have to be made of matter…Our description of nature is thus severely biased: we describe it from the standpoint of matter.*" (Schiller, 2009) p834

The light we see is less than 1% of the electromagnetic spectrum, so if we saw ultra-violet, as bees do, we would see a different world. Similarly, turning on a radio can pick up waves broadcast from all around the world, none of which our senses register. If our instruments show our senses are incomplete, why cannot our instruments themselves also be incomplete? Why do we hold so tightly to:

"*… the dogma that the concept of reality must be confined to objects in space and time…*" (Zeh, 2004) p18

By the logic of quantum theory, between our observations of "reality" is a quantum unreality, of which the Copenhagen doctrine says *we must not speak*. Since entities only interact for an instant, they are in-between measurements more than in them:

"*Little has been said about the character of the unmeasured state. Since most of reality most of the time dwells in this unmeasured condition …the lack of such a description leaves the majority of the universe … shrouded in mystery.*" (Herbert, 1985) p194

If the world exists mostly in unobserved, uncollapsed quantum states, by what logic are only its brief moments of collapse real? *Surely reality is what is there 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? If one *believes* quantum theory, seeing quantum states as unreal and physical states as real is like seeing the sun circling the earth, when it is really the reverse. If quantum states create physical states, by what logic are only physical states real? *Surely reality is what causes not what is caused*.

The current denial of the reality of quantum states is doctrinal not logical, a belief maintained by the positivist faith, against mounting evidence that quantum states are a non-physical reality and that quantum collapse has a non-physical cause.

Conclusion

In conclusion, by its observed behavior the physical world *cannot* be an objective reality, but it *could* be a virtual one spawned by quantum processes. When matter was first attributed to unseen atoms, scientists like Ernst Mach didn't believe it, but now we accept that matter is composed of atoms. Then atoms were discovered to arise from even smaller electrons, protons and neutrons, again unseen. Then nucleons were argued to arise from quarks that are ever unseeable, as they cannot exist alone. All this, science accepts as strange but true, but when quantum theory finds the most fundamental

constituent of all is a probability, we say "Enough!" This, it seems, is a step too far. How can the quantum answer to life, the universe and everything be just numbers[26]?

Table 3. Physical effects and virtual causes for light

Physical Effect	Virtual Cause
Light. A photon is an electro-magnetic wave which: a) Sets absolute positive and negative values in space b) Is a sine wave that turns in "imaginary" space but moves in our "real" space c) Moves at the fastest speed in any medium d) Never fades in amplitude e) Interacts entirely at any wavelength point	*Processing*. A photon is a processing wave which: a) Displaces the "surface" of our 3D space b) Turns a transverse circle in quantum space that projects a sine wave as it moves on our space c) Moves at the maximum cycle rate of the grid d) Is maintained by ongoing grid processing e) Can provide all its processing at any grid node
Energy. The energy a photon can deliver: a) Decreases as its wavelength increases b) Increases as its frequency increases c) Must be an integer multiple of Plank's constant d) Plank's constant also defines the size of space	*Processing rate.* The node rate of the Planck process: a) Decreases as the process is shared by more nodes b) Increases as each node carries out the process faster c) Must be an integer divisor of one Planck process d) The Planck process also defines the planar circle
Quantum waves. A quantum wave function can: a) Spread outwards as a spherical wave b) Go through two slits and interfere with itself c) Immediately collapse regardless of distance d) Have an event probability depending on the wave's power at each point	*Quantum instances*. Instances of a processing class can: a) Spread outwards as a spherical wave b) Pass through two slits then interfere on exit c) Immediately stop anywhere if the class stops d) Access and lock the class depending on the processing needed, i.e. the wave's power at each node
Quantum spin. A photon polarized in one plane exists in other polarization planes according to angle	*Quantum spin.* A photon's orthogonal quantum extent changes as it spins in our space according to angle
The law of least action. A photon at every point takes the path of least effort to reach a detector	*The law of all action.* Photon instances take every path to a detector, and the first to interact is physically the photon
Retrospective action. A photon decides the path it took to a detector when it arrives	*Just in time action.* A photon class decides which instance, and which path, interacts when it arrives
Non-physical detection. Lack of interference can prove there is an obstacle on a path not physically traveled	*Entity instance detection.* A detector blocking an alternate path stops the interference those instances produce
Superposition. A photon can exist in a combination of quantum states that are physically incompatible	*Superposition.* A class's instances can be physically incompatible as they can't overload the grid
The measurement problem. Observing the world creates physical reality	*The measurement problem.* The interaction we call observation creates the transfer we call physical reality
Entanglement. For entangled photons, one outcome affects the other, anywhere in the universe, instantly	*Co-processing.* When photon classes co-process, the effect is regardless of grid location
Holographic principle. All the information in a volume of space can be encoded on its surface	*Holographic principle.* All the information a grid node receives flows into it from its neighbors

It is to this place, that others shun, the virtual reality conjecture takes us, not to shock or amuse but to progress. It asserts what quantum theory implies – that a photon really is an unseen existence cloud, that this cloud can non-locally collapse, that it only physically exists when observed, that it chooses a

[26] 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.

physical path when it arrives, and that its counterfactual acts change physical outcomes. Only if the physical world is a virtual reality created by quantum processing are such things possible.

Quantum theory has dislodged the rock blocking our view of reality but who will step forward to look? Einstein held back, hoping the quantum brilliance would fade, but it never did. Bohr walked in wearing a Copenhagen suit to screen out all existential impacts, and his followers do the same. To this day, the entire area of quantum mechanics is in a sort of semantic quarantine, apart from the minds of most people, surrounded by a wall of arcane formulae, and mediated by a selected elite who put up warning signs like: "*Nothing here means anything*" and "*Everything here is imaginary* ".

If quantum theory implies a change to our understanding of reality, its meaning belongs to all those it affects. The walls of jargon around quantum theory need to be torn down, the general public invited in, and new signs put up saying "*Everything here means something"* and *"Nothing here is unreal".*

We suppose ourselves in the rational sunlight of physical reality, standing before a mysterious dark cave of quantum paradox, but in this model, as in Plato's cave analogy, it is the other way around. We stand in the darkness of physicalism, blinded by the quantum sunlight that:

- *The laws of physics are laws of processing*
- *The ultimate "particle" is information.*
- *Physical existence is a quantum process output.*
- *An unseen world creates the world we see.*

That quantum processing creates physical outcomes contradicts neither logic nor physics (Table 3). Indeed if the quantum wave is real the quantum paradox disappears, as rather than quantum unreality creating physical reality, now quantum reality creates physical unreality (or rather a virtuality that is locally real). It is hard to imagine physical matter as a hosted program, where moving your hand in space just passes programs to new processing nodes. Yet it is possible that nothing objective exists but quantum processing. In non-physical realism, the physical world is not a constant thing but an interface constantly updating its events. If quantum mechanics is a great smoky dragon (John A. Wheeler, 1983), then physical reality is just its smoke (Figure 27). Quantum states are then no shadow world running alongside a real physical world, but *the real world* of which the physical world we see is just a reflected shadow.

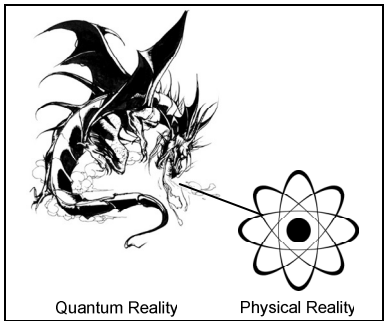

Figure 27. The quantum smoke

QUESTIONS

The following questions highlight some of the issues covered:

1. Do light waves oscillate in a physical direction?
2. Is the entire electro-magnetic spectrum one basic process divided?
3. Does the "imaginary" dimension of complex numbers actually exist?
4. Why does light uninterrupted never fade?
5. Why is light's speed the maximum for any medium?
6. What is energy in processing terms?
7. Why does electro-magnetic energy come in Planck units?
8. How can a light wave deliver all its energy instantly at a point?
9. Does one photon go through both Young's slits at once?
10. How does a quantum wave collapse instantly, regardless of its spatial extent?
11. What are counterfactuals and why must they exist?

12. Is light a wave or a particle?
13. How does polarized light pass entirely though a filter nearly at right angles to it?
14. Why is a photon's spin on any axis always the same Planck values?
15. Is non-physical knowing possible?
16. Does a photon choose its physical path to a detector *after* it travels?
17. Why don't physically incompatible quantum states clash?
18. Will scientists ever be able to see quantum waves?
19. How does the holographic principle arise?
20. How can an entangled photon instantly affect anywhere in the universe?
21. Do we create physical reality when we observe it?
22. If quantum states produce physical states, which is real?
23. Where do random quantum choices come from?

ACKNOWLEDGEMENT

Many thanks to my son Alex for insightful comments and suggestions and to Alasdair Broun for ideas on consciousness.

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