Chapter 5. Matter Teleports[1]

"In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual."

Galileo Galilei

Brian Whitworth, New Zealand

5.1. INTRODUCTION

5.1.1. Quantum theory vs relativity

A hundred years ago relativity and quantum theory revolutionized physics, replacing the Newtonian model of the previous 200 years with a world of malleable time, curved space and matter waves. A century of research has confirmed both theories in their respective cosmic and sub-atomic domains *yet they contradict each other*, as relativity gives infinities at Planck lengths and quantum field tricks fail for gravity. Two *theories that contradict each other can't both be right*, suggesting something more fundamental is at play. This schism existed at the heart of physics last century and as the graviton proposed in 1955 hasn't been found, essentially nothing has changed in over fifty years.

According to quantum realism, quantum theory and relativity conflict because each exposes the other's conceptual baggage but ignores its own:

1. *Quantum theory:* Assumes that quantum states evolve on a static *space-time background*, (Smolin, 2006) that relativity assures us doesn't exist.
2. *Relativity theory:* Assumes that *foreground objects* follow fixed trajectories, that quantum theory assures us doesn't happen.

The reconciliation proposed is that *quantum processing* creates both objects and their space-time context. The last chapter replaced Aristotle's particles with a quantum processing network and this chapter aims to do the same for Newton's space-time canvas. It explains relativity by the same model that was used to explain quantum theory.

5.1.2. A quantum processing model

Two millennia ago, Aristotle saw a world of matter, with space just the emptiness between objects. Today we know that matter is less than 4% of the universe, yet particles still rule physics so based on *no data at all* gravitons still appear in the pantheon of standard particles. And consider that a proton's mass is a 100+ times more than the quarks that compose it, so where does

[1] For the latest chapter versions see http://thephysicalworldisvirtual.com/ For an explanation of terms in italics please refer to the Glossary at the end of this chapter.

the extra mass come from? Every problem in physics today is answered by a particle, so massless *gluons* are said to create it, but since they are *virtual*[2] it follows that 98% of the mass around you comes from what is essentially imaginary. Aristotle's belief in the reality of matter is now sustained by particles with no substance made by the empty space he called nothing at all!

Are any physicists asking the obvious question: *What if Aristotle got it wrong?* If space is just what keeps matter apart, how can gluons *from space* create mass? Matter dominates our earth view, but if we view the universe at large it surely consists mainly of space and light.

In quantum realism, quantum processing generates matter in space as physical processing generates a pixel on a screen. So just as even if all the pixels turn off your screen still remains, so even if all the matter in the universe vanished the screen of space would remain. In this view, space is "something" in its own right. Indeed, everything began with the nothing we call space, then came pixels of light, and then the matter glitch, making matter a distant third in the scheme of things.

In this approach a photon is quantum processing in a *client-server* relation, where a *server* gives a resource to one or more *clients*, so a computer printing a document is a server giving data to a printer client. Since the computer is fast and the printer is slow, one server can keep many printers busy. If there is a client error, if a printer jams, the *computer server* just resends the data. In the quantum case what is shared is dynamic processing not static data. A photon server shares its processing among many nodes on the quantum network, so it really does go through both slits of the two-slit experiment at once. Th quantum server *instantiates* its processing on many client nodes in the quantum network we call space. If any part of that network overloads, it restarts just as we reboot a hung computer. When a photon hits a screen many nodes overload and try to restart but only one can reload the photon server processing. What physics calls the *collapse of the wave function* is the disbanding of client instances when a server process restarts.

5.2. SPECIAL RELATIVITY

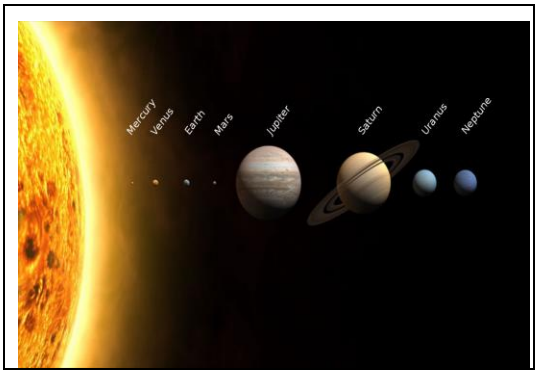


Figure 5.1. *How fast are we moving?*

If quantum theory is strange, relativity is stranger because it affects time and space.

5.2.1. The movement mystery

Maxwell's equations describe light as a wave so a superfine *ether* was assumed to propagate it. Since the earth orbited the sun to give the seasons, and its spin gave night and day, the ether wind couldn't always be stationary (Figure 5.1). The speed of light should vary: light going against the wind should go slower and light going with the wind should go faster. Yet in 1887 Michelson and Morley found to everyone's surprise that the speed of light was the same in every direction. There could be no ether wind! This was deeply counterintuitive - how could the movement of the earth not affect the movement of light?

[2] Physics uses virtual differently from quantum realism, to refer to a causal agent that science *cannot* experimentally manipulate, inferred from equations that work. In quantum realism virtual refers to a property of the physical world that we can test. So the latter is scientific but the former is not.

In 1904 Lorentz found that the equations of light stayed the same if space and time changed as objects moved. In 1905 Poincare deduced the *relativity principle*, that the laws of physics were the same in every reference frame, so a ball thrown up in a moving car acts the same as in a stationary car. A feature of our world is that all constantly moving observers get the same laws of physics, so a scientist who throws a ball, swings a pendulum or shines a flashlight on a rocket gets the same results as on earth.

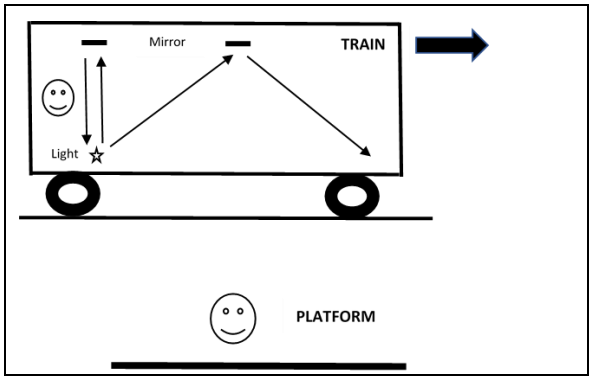


Figure 5.2. Einstein's moving train

This is fortunate because the earth is in fact a planetary rocket carrying us through the cosmos. Its spin whirls us at 1000mph. Its solar orbit moves us at 66,000mph and its galactic orbit at 483,000mph. Our speed relative to cosmic radiation is about 1,300,000 mph, yet science works on earth as it does in the rest of the universe. So how is our reality bubble maintained?

5.2.2. Why the universe *isn't* weird

Einstein saw that for the universe to be as Poincare described, space and time had to change as Lorentz described. He imagined a moving train where a floor light reflects from a mirror on the ceiling (Figure 5.2). A passenger on the train sees the light go up and down, but an observer on the platform sees it travel a longer path in the same time. If time and space are the same for both, they get a different speed of light and different physics. Einstein's conclusion was that space had to shrink and time dilate to keep the speed of light constant, otherwise flashlights might not always shine and mirrors might not always reflect! Lorentz saw his transformations as a mathematical curiosity but Einstein saw them as real because they made Poincare's relativity principle work. Time and space changing made physics *invariant*[3].

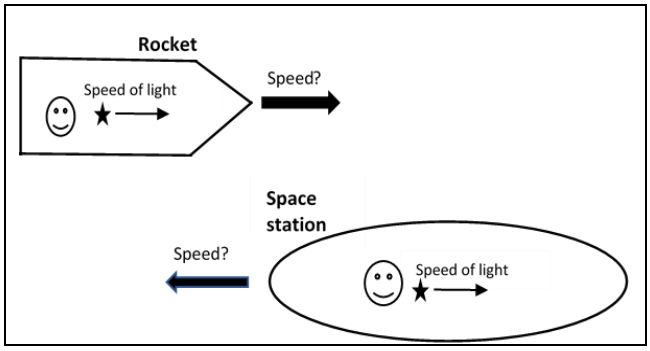


Figure 5.3. A rocket passing a space station

Imagine a rocket flying past a space station in orbit (Figure 5.3). Those on the rocket and on the space station both measure the speed of light. It doesn't seem possible that they both get the same result but they do! Einstein says it is because time and space change when one moves. Yet who is really moving – is the rocket going past the space station or is the orbiting space station rushing past the rocket? It turns out that it doesn't matter. If the rocket moves, its space and time contract and dilate, or if the space station moves the same applies. Regardless of how the rocket and station move *relative* to each other, *distance* and *time* change just enough to keep the speed of light the same for both. It seems weird that time and space change to keep our view the same however we move but as Einstein said, *this is why the universe* ***isn't*** *weird*.

[3] Einstein preferred the term invariance for his theory but relativity stuck.

5.2.3. Light maintains causality

Why is the speed of light constant not say the speed of lead? Why is light the *gold standard of movement?* Imagine a rocket going at nearly the speed of light to a planet and then returning to earth. If the speed of the rocket affected the speed of light, a message sent on the journey **to** the planet might arrive after one sent on the way **back**. If the rocket exploded after rounding the planet, one might *first* see the blast *then* get a message from the crew that all is well, like a cheery Facebook message from a person after their funeral. Light, as the messenger of reality, can't get causality backwards.

The possibility of faster than light travel gave rise to the Star Trek "great betrayal" story, where the Klingons signed a peace treaty to get human technology then built a faster than light missile to go *back in time* to destroy the departing Federation ship (Al-Khalili, 2008 p26). Faster than light movement interferes with the natural causality of things.

Einstein didn't say *how* space and time conspire to keep light speed constant, but it surely isn't for our convenience, as Nature doesn't need us to understand it. Since it takes work to *move* matter but it takes work to *stop* light moving, clearly *matter moves differently from light*. If I drive at 100mph and throw a brick forward at 10mph it goes at 110mph, but if I shine a torch light doesn't go at the speed of light plus 10mph! How does light, *and only light,* do this?

5.2.4. Time dilation

According to Einstein, the speed of light stays the same because time slows and distance shortens as matter moves, so a *matter* clock carried by a photon would freeze as *time stops for light*. A photon from the Andromeda galaxy takes 2.5 million years to get here but according to relativity, for the photon itself no time at all passes[4]. Needless to say, this makes no sense, for if time stops for a photon how does it move at all? Clearly something is not right here. It seems that *matter time* doesn't apply to light.

In a classic thought experiment, Einstein imagined a twin leaving on a rocket that returns after a year in space to find his brother an old man of eighty! This could happen because a muon travelling at 99.5% of the speed of light that should travel 300 meters in its millionth of a second life but actually travels 3000 meters, i.e. its speed extends its life tenfold. Relativity lets a traveler in a rocket accelerating at one *g* to get to our nearest galaxy and back in their 60year life, but they would return to find the earth four million years older (Harrison, p157). Every galaxy ticks at a different time rate, but a lifetime in any one would seem the same.

5.2.5. The universal speed limit

Light goes at the fantastic speed of 670 million miles per hour, about the distance to the moon in a second. Can we get to this speed? What about a leap-frog method, like a rocket going at half the speed of light that shot a bullet forward at half the speed of light? Unfortunately, doing this makes time and space change so the bullet only goes at four-fifths the speed of light!

How about gradually accelerating a rocket to slowly reach the speed of light? Nature again intervenes by increasing the rocket's *mass*, until at near the speed of light a near *infinite mass* needs a near *infinite force* to move it. This seems to contradict the conservation of mass and the law of thermodynamics, that energy in a closed system can't be lost. Einstein's answer was that

[4] It also says that light starts and ends its journey at the same location, by length contraction.

energy and mass convert, by $E=mc^2$, so nothing is really lost. He didn't say whether mass was a form of energy, energy a form of mass, or both were aspects of something else.

In theory, in a rocket going 5mph slower than the speed of light one could throw a ball at 5mph per hour to reach the speed of light, but in practice one can't produce the force needed to throw the ball. One might expect light in the rocket to move at almost twice the speed of light but Nature plays with space and time to keep every reference frame the same.

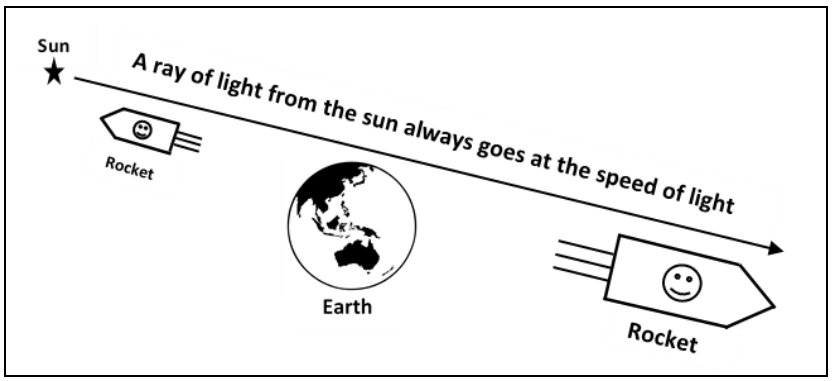


Figure 5.4. A ray of light always travels at the speed of light![5]

Suppose earth sent off two rockets at half the speed of light, one to the sun and one to Pluto (Figure 5.4). According to relativity the same light from the sun passes both rockets and the earth at the same speed! Yet how can *one photon* pass both rockets, one going to the sun and the other away from it, at the same speed? This makes no sense in classical or indeed any other terms.

The problem with relativity and with quantum theory is that the equations work but make no sense. How can the space that is the measure of movement itself move? How can time that is the measure of change itself change? Einstein *deduced* that space-time changes but didn't *explain* it. Last century we expected to unravel the mystery in time, but 100 years on we are no wiser.

5.3. HOW MATTER MOVES

In quantum realism, matter is quantum processing that repeatedly restarts while light is the same processing on the move, hence it takes energy to *start* matter moving but takes energy to *stop* light moving. Yet how can matter, as an *inherently stationary* standing wave, move at all?

5.3.1. The mystery of matter movement

In quantum realism, quantum processing at a point on the quantum network immediately spreads as a quantum wave by the *pass-it-on protocol*, whether it is light or matter. That a photon spreads out to take every path as it "travels" to a point destination is why the Feynman integral over histories method works. It is not unusual that one photon goes through both slits in the two-slit experiment if it is quantum waves spreading not a particle. It only *looks like* a particle when it hits the screen when its processing restarts at a point. If a photon is like a moving boat whose quantum engine spreads ripples in all directions, matter is like a boat that is stationary but whose quantum engine still spreads waves in all directions.

A *physical* standing wave doesn't move nor does a *quantum* standing wave, but the latter restarts repeatedly. Matter restarts every quantum cycle and *where* that restart occurs depends on the processing distribution around it. The "trembling" or zitterbewegung of matter was deduced by Schrödinger from the Dirac equation for electrons but the logic applies to all matter. If the processing around matter is symmetric, its quantum "tremble" *on average* has no effect and on a

[5] Earth picture from https://pixabay.com/en/earth-map-globe-world-australia-145504/

macroscopic level it is "stationary". Yet even a tiny bias in the surrounding processing that makes it restart one way more than another will cause movement in our time because quantum events occur at such a fantastic rate[6]. Matter as processing restarting is always randomly quivering. If the load nearby is symmetric the quivers cancel but if not, they cumulate into visible movement.

Yet it isn't strictly correct to say quantum matter "moves", as processing restarting at a new point is essentially a *teleport*. That matter does this is illustrated by quantum tunneling, where an electron in an impenetrable Gaussian field suddenly appears outside it, like a marble suddenly popping out of a sealed bottle. It didn't *travel a path* out, as it can't exist in the intervening field, so it must have just teleported, and the last paragraph suggests that *all matter moves this way*. Matter can "just arrive" at any point in its quantum distribution by restarting there. That light *transmits* by a path but matter *teleports* suggests answers to the mysteries of special relativity.

5.3.2. Movement changes space-time

According to relativity, as matter moves faster, time and space adjust *exactly* to keep the speed of light constant. In quantum realism this occurs because if an entity restarts one node to the right, any measure *it makes* in that direction is a pixel less, i.e. distance shortens. And if this teleport interrupts a life cycle then that cycle of its life didn't occur, i.e. time dilates. If matter spends a quantum cycle "in transit", that cycle isn't part of its life. For matter, life and movement share a limited resource - quantum cycles - that can give one or the other but not both at once. If distance is measured from where one is, a teleport one way shortens distance that way, and if time is measured in life cycles every teleport/move steals a life cycle. Together, these two effects ensure that however matter moves the speed of light is always constant.

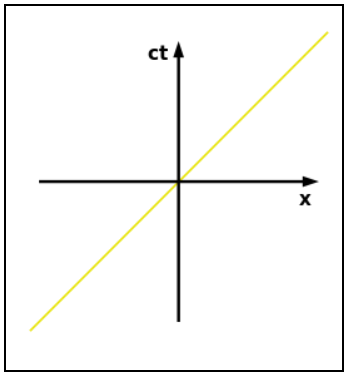


Figure 5.5. *Space-time diagram of a photon passing a point*

In the space-time diagram of a photon of light passing stationary matter (Figure 5.5) the photon moves a point of distance per point of time to give a 45º line, i.e. the speed of light. When matter teleports, losing a point of distance and a cycle of time in effect slides the time axis down and the length axis right by one point. Since the photon still passes through the zero-point, shifting both axes by one means the photon line is still 45º, i.e. the speed of light. Relativity seems strange because we focus on *pointer changes not origin changes*.

In Figure 5.4 *the same photon* from the sun passes both rockets and the earth at the same speed of light because matter alters its time and space as it moves, just as Einstein said. That matter loses distance and time as it moves explains why.

By Einstein's theory every body of matter has *its own space and time*, so its incorrect to talk of "space and time" without specifying for what? Time passes slower for objects that move faster or are heavier even though to themselves their life has the same number of quantum cycles. *Matter time* is measured by quantum cycles in one place because teleport cycles don't count. Applying matter time to light creates contradictions because light never stays in one place for a cycle. Einstein's equations predict that "Time" stops for light, but actually *matter time* doesn't apply to light, and for it *quantum time* still passes.

[6] It takes light 10^{-44} secs to move a Planck length in space. If a photon is passed on every cycle, the frequency of space is 10^{+44}. The quantum rate is about a quadrillion, quadrillion Petahertz, while our best computers are just one Petahertz (quadrillion hertz). Matter restarts itself that often a second!

5.3.3. Kinetic energy

Previously, a photon's *radiant energy* was the quantum processing it transferred per cycle. Increasing a photon's wavelength divides the same processing more so the amount transferred per cycle (energy) reduces. *Kinetic energy* as energy of movement seems unrelated to radiant energy but when photons hit a solar sail it moves so the two forms of energy must relate. The basis of this is now proposed to be photons.

If a matter entity consisting of many entangled photons acquired one more photon that would bias its processing in the direction of that photon. When photons hit a solar sail they don't disappear but entangle with the sail's matter. Acquiring a directional photon alters the processing distribution of the solar sail matter, to bias it more in one direction, and over time this asymmetry gives movement in that direction over time. If kinetic energy is when matter acquires photons, it has the same basis as radiant energy.

How can matter acquire extra photons? Family generations of leptons and quarks show that point matter has spare channels but as photons occupy them interference increases mass. If matter moves by acquiring photons then mass should increase as objects move faster, and it does. Mass increases as matter moves for the same reason that higher generations of leptons and quarks increase mass.

The increase isn't linear because interference doesn't work that way. Minor load increases on road networks can give major traffic jams, and information networks like the Internet are the same. As more photons make an object move faster they give more interference that increases processing i.e. mass. The mass increase is non-linear and tends to infinity because this is how interference increases with load.

Kinetic energy based on photon acquisition isn't quantized because a mass of many points can acquire one photon, dividing the change to any degree. One photon is the quantum of energy but it can entangle with a mass of many points. A large mass that acquires one photon in effect shares the photon, hence larger objects are harder to move. The basis of inertia is that matter entities in a mass entangle, so the effect of adding a photon is shared. The graviton search failed because the effect of each photon a mass acquires can divide among a mass of any size, so gravity isn't quantized.

When a moving body hits another, the photons that cause its kinetic energy are passed on, so kinetic energy at the quantum level is a photon exchange just as radiant energy is. In current physics, energy is an abstract that is conserved but in quantum realism photons are conserved.

Figure 5.6. *Avatars in a forest*

5.3.4. Bit-shifting reality

In an objective world, there is one type of movement but virtual worlds always have two. In Figure 5.6, one can move the avatar pixels left but moving the forest pixels behind them right has the same effect. The avatars move *relative* to the forest in both cases. Programmers can move an image by *bit-shifting* the foreground or background equally easily. The avatar pixels can move across the screen or they can keep a center-screen *frame of reference* as the forest pixels scroll behind them. Now our reality also has two movement types, of light that is absolute and of matter that is relative to a frame of reference. Light and matter move differently, just as in a virtual reality. Light is like a pixel

crossing the screen while matter is like a center-screen image with background scrolling, where bit-shifting space is the equivalent of moving the zero-point described earlier. When moving in a fast car or plane it isn't hard to imagine we're still and the world scrolling by perhaps because it is in fact so.

To Aristotle, substantial matter existed at every point on its movement path but in a virtual reality "a pixel moving" is just being recreated at sequential points. A dot re-created at one point after another looks like a "thing" moving, but actually each point is a new event unrelated to the last, so *nothing actually moves*. In the same way, movies show one image after another to suggest an object moving but again there is no "thing" that moves, only sequential images created anew. An image rapidly recreated seems to exist but actually each image is freshly created. We know this, yet when electrons bounce off each other we still see those that went in as also coming out, when in fact they are fresh off the quantum press. The electrons that come out look like those that went in because processing is conserved, not due to any particle or matter "substance".

When a computer shows a pixel at a set of sequential points, a "particle" seems to move, but really there are only events. What physics calls particles are quantum waves creating physical event instances that appear for a moment then disappear forever. As your hand moves it seems to exist continually but at the quantum level there is no substance, only the continual generation of an image. If the physical world is just a series of images with no inherent constituent, it is indeed "empty of substance".

5.4. GENERAL RELATIVITY

Special relativity applies to constant speeds but what about acceleration?

5.4.1. The gravity mystery

We don't directly feel constant speeds but we do feel a force when our speed changes. We feel the force of gravity pulling us to earth but in a free fall we don't feel anything at all pulling us down. As Douglas Adams said "*It's not the fall that kills you; it's the sudden stop at the end.*"

Einstein later called "*the happiest thought of my life*" realizing that falling from a building is like being at rest in space! The force of gravity is *equivalent* to acceleration, so a person accelerating in a rocket at 1g feels a force pulling them down exactly like gravity on earth. Galileo showed that, but for friction, masses fall at the same rate because gravity and inertia both increase with mass. Einstein added that the two effects balance exactly because acceleration and gravity are the same thing.

Einstein concluded that this wasn't possible in a fixed space-time, so mass had to warp the time and space around it. He replaced Newton's inexplicable force-at-a-distance idea by general relativity, where every mass distorts the space-time around it to cause its gravity. Newton's space was the fixed stage upon which events unfolded, but Einstein's matter changed space that in turn defined how matter moved. In general relativity, gravity distorts the space and time around it so particles following "straight" paths now curve as if under the influence of a force. Gravity distorts space-time which redefines what it means to move in a straight line. Note that this explanation has no need for particles to "cause" the force of gravity.

5.4.2. Gravity as a processing gradient

Newton believed, as did Aristotle, that matter is inert, and so wrote:

> "*It is inconceivable, that inanimate brute matter should, without the mediation of something else, which is not material, operate upon, and affect other matter without mutual contact;…*" (Wilczek, 2008) p77

Newton discovered gravity but found it *inconceivable* that inanimate matter caused it! Then Einstein attributed gravity to space-time distortions but ignored how inert matter could alter space or time. Physics today still believes, as Newton did, that *particles cause forces*, so when electro-magnetism was found to occur in photon units it was proposed that *virtual photons* from space itself caused it. The equations worked so no-one argued and thus began the practice of inventing virtual boson particles to explain after the fact equations. The convention became that to "prove" a particle agent one only needed an equation that worked plus an accelerator event that showed the agent "existed", however briefly. So physics spent much of last century devising equations to fit the facts then cherry-picking accelerator events to match their terms. No-one queried this trick because it worked, yet one force resisted, gravity, to cast doubt on every other virtual agent.

In quantum realism, the virtual bosons of current physics are magical causes invented after the fact. The last chapter explained the facts of matter by quantum processing and this chapter does the same for gravity. Matter as processing that restarts every cycle spreads on the quantum network, just as a photon spreads copies itself through both slits in the two-slit experiment. By Gauss's theorem, this spreading flux of quantum processing will reduce as an inverse square with distance[7] (Figure 5.7). The resulting *quantum processing gradient* is now proposed to be the basis of gravity.

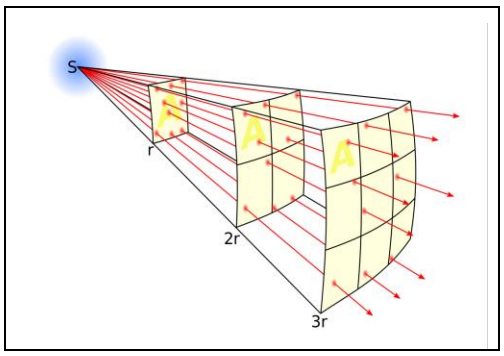


Figure 5.7 *Gauss's flux law*

A large mass like the earth spreads processing on the quantum network that alters the load around bodies nearby. It increases the load nearer to itself, making an overload that way more likely so on average the body restarts more often, i.e. it moves. Matter doesn't move because it is pushed, but because the processing load around it is asymmetric. The nature of mass is to constantly restart, so if the local network is busier one way its ongoing "trembling" will go more often that way. The gravity gradient moves nearby bodies by changing what the quantum network around them is doing.

Each restart entangles the earth with the other body so photons may exchange. As the earth is much larger the smaller mass will acquire photons in the earth's direction, which is kinetic energy, as concluded earlier. If that body then hits another, those photons transfer as kinetic energy. As explained, for matter to accelerate it must constantly add photons, and a body that falls to earth increasingly acquires photons from the earth, so *gravity is equivalent to acceleration because both have the same quantum cause*.

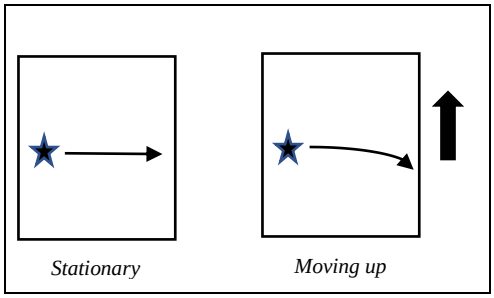


Figure 5.8. *Light bends when lift moves up*

5.4.3. Gravity bends light

Einstein deduced that gravity bends light by imagining a flashlight shining horizontally in a lift accelerating upwards (Figure 5.8). As the lift rises the light curves relative to it, so if gravity is like

[7] The flux transferred across a sphere surface reduces as the inverse square of its radius $1/r^2$. Newton's law of gravity $F = g.m_1.m_2/r^2$ with m_1 and m_2 masses and g constant is an inverse square flux law, as is Coulomb's law $F = k.q_1.q_2/r^2$ with charges q_1 and q_2 and k constant. Both laws come from Gauss's flux law.

acceleration it should bend light. Light should "fall" by gravity just as matter does and light passing the sun is indeed bent. The analogy worked but how does inert matter reach out to move massless light?

In processing terms, matter bends light as it does matter, by altering the processing around it. Light moves by spreading its processing in every direction. As it passes the sun, the greater load nearer to the sun slows down transfers in that direction. The wave front bends towards gravity, just as light bends towards water that slows it down in refraction (3.4.2). If one side of a light wave has a higher load, those slower transfers skew the light that way. Light has no mass but it has processing, so the gravity gradient affects it.

5.4.4. Everything in its own time

By the special theory of relativity every mass in the universe *has its own clock.* I have one, you have one and our nearest star has one. Matter time is relative to speed, so we only have the same time if we have the same speed. Time also slows down near a large mass like the earth because the processing load around it makes quantum cycles take longer. A lot of computing is needed to make satellite navigation work because the internal clocks of GPS satellites far from earth tick at a different rate from the receivers on the ground. Astronauts who went to the moon lost a few seconds of life so people who lived there would be noticeably older.

All this weirdness occurs because matter time is virtual, i.e. it passes when quantum cycles complete. Speed alters time because a movement teleport replaces a life cycle, and gravity slows time because it spreads processing that makes quantum cycles take longer. So would one live longer on a bigger planet? It might seem so to others but the quantum cycles you *experienced* would be the same, so it wouldn't feel so. The strange behavior of our virtual time is entirely fair.

5.5. CHARGE AND MAGNETISM

In current physics mass and charge are inherent properties of matter with no connection, but in quantum realism mass and charge are two sides of the same processing coin:

1. *Mass:* The net processing that repeatedly overloads a node.
2. *Charge:* The net processing that remains after the overload.

All matter arises from a processing overload and charge is the remaining positive/negative processing. This remainder spreads as an *electric field* that also decreases as an inverse square on the quantum network. This system handles every processing problem by passing it on, so any remainder spreads until cancelled by an opposite.

5.5.1. The quantum cycle

To understand the effect of an electric field it is necessary to review the details of a quantum cycle. The *quantum network* response to load is to pass it on, so a quantum cycle has two phases:

1. ***Share***: Pass on current processing to neighbor nodes:
    a. *Cancel remainders*: Cancel any positive/negative remainders.
    b. *Share processing*: Divide any processing/remainder among neighbors.
2. ***Execute***: Carry out all the processing received from neighbors.
    a. *IF an overload*: Request a restart from the server(s) involved.
        i. *If ignored*: If no server response, drop the job as a *quantum collapse*.
        ii. *If accepted:* Reload from the server(s) as a *physical event*.

Gravity affects the *execute phase*, as a massive body makes nearby matter more often restart towards it. Charge in contrast affects the *share phase*, because a remainder takes time to pass on. Between opposite charges, the remainders cancel, so the quantum network runs faster and so these nodes get server access sooner. So opposite charges attract the same way that gravity does, by biasing quantum network restarts in a certain direction. In contrast for opposite charges the quantum network run slower between them, causing movement apart.

In summary, two factors affect where a matter body restarts:

- *Whether* the quantum network overloads.
- *Which* quantum network parts overload first.

Gravity moves matter by changing the first property, while charges move by changing the second, with the latter effect more powerful than the first. The gravity gradient biases the *processing load* while two charges bias the *cycle rate* between them. It follows that gravity and charge both come from the matter processing.

5.5.2. Electro-magnetism

Magnetism was once thought to be separate from electricity until the same equations were found to describe both. Today light is said to be an electric vibration sustained by the magnetic vibration it creates, even though it isn't possible for two forces to mutually cause each other!

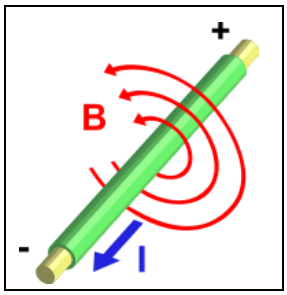


Figure 5.9. *Current I creates magnetism B*

A static charge isn't magnetic but when it moves a magnetic field appears around it (Figure 5.9), so if you wrap a wire round a nail and pass a current through it, the nail becomes a magnet. The magnetism stops when the current stops, so does magnetism come from charge? Yet if you wrap a wire round a magnet and spin it a current is induced in the wire, so does magnetism create electricity? That electricity creates magnetism which in turn creates electricity is just another paradox that current physics has learned to accept.

Some say magnetism is charge in another guise[8] but if so, why don't magnets affect static charges? Why does magnetism act at right angles to the electric field? Why does it reduce as a cube not an inverse *square* like electricity? Separating a charged body gives positive and negative parts but dividing a magnet gives two more magnets each with north and south poles, not a north pole and a south pole. Yet Maxwell's equations connect magnetism to electricity so:

> *"We will see that magnetism and electricity are not independent things – that they should always be taken as one complete electromagnetic field."* (Feynman, Leighton, & Sands, 1977)[9]

In current physics, when charges repel, virtual photons are said to batter them apart, and when they attract, virtual photons push them together. Magnetism is also attributed to the same virtual photons, even though it works quite differently. As long as the equations work, physics seems happy to attribute electro-magnetism to fairies with photon wands.

---

[8] Stating that a moving electron's length is foreshortened by special relativity giving more negative electrons than positive protons in a given length of wire, so parallel wires with opposite currents attract.

[9] The Feynman Lectures on Physics Vol. II Ch. 13: Magnetostatics

Yet understanding electricity and magnetism separately doesn't explain electro-magnetism, any more than understanding horses and birds would explain a winged horse. That a field can be electric or magnetic depending on reference frame doesn't explain how *one* field has *two different* effects (charge and magnetism) that work in different directions and weaken differently. Indeed, physics has *never* really explained what electro-magnetism actually is.

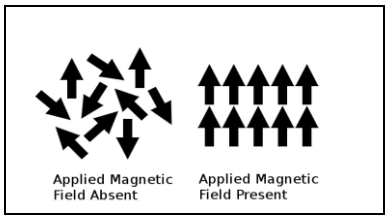


Figure 5.10. *Magnets combine*

5.5.3. Magnetism is quantum spin

Cutting a big magnet in two gives two smaller magnets and joining two small magnets gives a bigger one. If big magnets come from smaller ones (Figure 5.10), all magnets can come from the smallest possible magnet, an electron, which acts like a tiny magnet because it *spins*. Spin is the third quantum property of matter, after mass and charge. In current physics an electron is a point particle that can't spin, but in quantum realism it's photon structure really does spin. *All* quantum entities spin because processing *spreads* in angular as well as linear directions. Spin is just another pass-it-on path that is "up" and "down" for clockwise and anti-clockwise directions.

Quantum spin creates a magnetic dipole, so every electron is essentially a little magnet whose north pole is its spin direction. If the electrons in a material spin randomly the net effect is zero but if they align the result is a magnet. Metals become magnets when their electrons align spins but plastics can't do that because their electrons aren't free to align. *All* magnetism occurs when electrons align their spins.

Just as matter spreads mass and charge on the quantum network, it also spreads spin. When electron spins align there is a magnet so *magnetism relates to quantum spin*. The Pauli exclusion principle is the after-the-fact rule that opposite-spin electrons can occupy the same point but same-spin electrons can't. In quantum realism, two opposite spin electrons can occupy the same point if they fill different parts of quantum space. Recall that an electron must rotate twice[10] to return to the same state (4.7.2), so if one electron spins clockwise and another anti-clockwise *they never overlap* even at the same point. In contrast same-spin electrons at a point compete for the same quantum space that only one can fill. The Pauli exclusion principle follows directly from the nature of quantum space.

Magnets spread processing on the quantum network with the same spin, so in between opposite magnets it doesn't compete by the Pauli exclusion principle. In effect, processing between opposite magnets is more dilute so cycles finish faster. This causes movement as charge did, by biasing the matter restarts. In contrast, processing between same poles competes for the same space so cycles take longer giving repulsion. Magnetism as spin interacting alters how *processing distributes* on the quantum network. Opposite magnets dilute processing between them and so attract while same magnets concentrate processing between them and so repel.

Attributing magnetism to quantum spin also explains its properties. Charge can divide into positive and negative parts because a processing remainder is absolute, but spin is relative, as clockwise from one side is anti-clockwise from the other, so magnets divided give more magnets. Charge radiates outwards but magnetism as spin direction acts at right angles to that. Charge spreading in two dimensions reduces as an inverse square but spin spreads in three and so diminishes quicker. Electricity occurs when electrons move, and since electrons are one-dimensional matter their *matter axes* must align in the movement direction for this to happen.

[10] Where one rotation is 360º and two rotations is 720 º.

Electrons must align their matter axes to move as electricity and this also aligns their spins to give magnetism. A current creates a magnetic field because electrons align their spins when they move. Conversely, when a magnet moves, the magnetic field changes at right angles to a line from the magnet causing electrons to move that way as a current. The properties of magnetism can be attributed to the properties of quantum spin.

5.5.4. There is only one field

Emboldened by the success of Faraday's fields interpreted as particle effects, physics began to invent new fields that in effect added dimensions to space[11]. Gravity required one-dimension, electro-magnetism two, the strong force three and the weak force two. These eight extra dimensions plus the three of space are why string theory needs *eleven dimensions* to work. String theory is a mathematical *description* not a scientific theory because it doesn't predict, and that a universe of eleven dimensions somehow collapsed into ours is a far-fetched idea.

So far, the properties of mass, charge and spin define the basic fields of physics, namely gravity, charge and magnetism. Matter spreads its net processing (*mass),* net remainder *(charge)* and angular direction *(spin)* that in turn cause the *fields* of:

1. *Gravity*. A processing gradient that affects matter round it.
2. *Electricity*. A remainder gradient that interacts with other remainders.
3. *Magnetism*. A spin gradient that interacts with other spins.

Matter isn't passive substance but dynamic processing that spreads on the quantum network to give the effects we call gravity, charge and magnetism. It restarts probabilistically at points around itself, like a flickering image that "jiggles" every frame, so any processing bias around it turns this natural quantum movement into macroscopic movement. Matter spreads a processing gradient that biases the quantum network as *gravity*. Charged matter spreads a processing remainder that interacts with other charges as an *electric field*. Magnetic matter spreads a spin alignment that interacts with other magnets as a *magnetic field*. The attractions and repulsions, of gravity, charge and magnetism occur because at the quantum level matter is always restarting, giving it a constant "jitter". Gravity, charge and magnetism affect matter by biasing its natural quantum movement, not by creating virtual particles from nowhere to "make" it move. Fields act at a distance because matter as processing is not confined to a location nor is it inert. Since the fields of gravity, electricity and magnetism all come from matter processing, one could talk of a *gravito-electro-magnetic* field, but it is simpler to call it the *quantum field*.

5.6. ENERGY AND ENTROPY

5.6.1. Potential energy

In current physics *potential energy* is described as energy based on *position*. Raising a body creates an energy potential that reappears as kinetic energy when it falls. Raising an object stores potential energy that is returned later when it falls. This balances the ledger, so energy isn't lost or made, but what stores and releases potential energy?

It is easy to forget that potential energy is an idea not a mechanism, e.g. if a rocket leaves the earth to go into a steady orbit where does the liftoff energy go? If the rocket leaves earth and travels in space forever, where is its potential energy stored forever? And if it later crashes on

[11] Mathematics calls these dimensions degrees of freedom.

Jupiter to release more energy than it took to leave earth, where did the extra come from? Is energy only conserved if everything stays in the same place, which it never does?

Those whose job it is to explain physics say that if the Jupiter rocket was reassembled and returned to earth the energy would be restored, but imagine applying that logic to entropy, saying a cup broken on the floor has "potential entropy" because it can be reassembled! People would ask how is this potential entropy stored? So how is potential energy stored? Is it stored in space, matter or gravity itself? Kinetic energy lost to friction becomes the thermal energy of heat, so there is a means of energy exchange, but a ball raised up loses kinetic energy to where? With no known means, is potential energy just a way to pretend that energy is conserved when it isn't?

5.6.2. The conservation of photons

Energy as force applied over distance is the capacity to do *work*. By the law of conservation of energy, the energy of a closed system should be constant, so does our universe conserve energy overall? Since our universe is expanding, the wavelength of every photon in it is now longer than a moment ago, so it also has a bit less energy now than it did. The cosmic background radiation that was once white hot is now freezing cold because the expansion of space took its energy and didn't give it back, i.e. energy isn't universally conserved.

The coldness of cosmic background radiation challenges the naïve view that we live in a closed system. Also, a system that expands *into* something can't be closed, nor can it have a constant energy because to expand requires energy. The expansion of space is the exception that breaks the rule that energy is universally conserved. Energy is conserved locally as solar panels, dams and windmills convert radiant, wind and gravitational energy into electricity, but it isn't universal. Just as the currency in a country might not physically change but inflation still decreases its value, so the expansion of space devalues energy globally.

What is conserved however is the number of free photons, i.e. quantum processing. When a solar sail turns *radiant energy* into *kinetic energy* the photons go into the matter, i.e. are conserved. When a rocket crashes on Jupiter with more energy than it took to leave the earth, energy isn't conserved but photons are because the rocket acquires photons from the mass of Jupiter via its gravity. Energy is conserved when photons are conserved and when energy isn't conserved, photons are still conserved. When our universe began, *inflation* made a finite number of photons that since then have remained constant. Our universe is made up of these photons in various forms, whether as light, matter or gravity, and they are always conserved.

Every physical event is a processing reboot and in any reboot the processing before and after is the same, i.e. quantum processing is always conserved. Current physics conserves matter, charge, energy, momentum, isospin, quark flavor and color, but each "law" is partial, e.g. matter isn't conserved in nuclear reactions and quark flavor isn't conserved in weak interactions. In quantum realism all these partial conservations become the *conservation of quantum processing*: that for any physical interaction the before and after quantum processing is always the same[12].

5.6.3. Entropy rules?

The laws of classical physics are reversible, so reversing a video of earth orbiting the sun breaks no laws of physics. Yet reversing a video of an egg breaking evokes laughter even though at the atomic level every event in the breaking is just as reversible as the earth's orbit. In our

[12] Except for the initial event, but see 2.5.1.

world things break apart more easily than they come together. It takes a lot of evolution to produce an egg that life can just break in a second by Murphy's law[13].

The second law of thermodynamics is the formal reason why eggs don't "unbreak". If *disorder* always increases for a closed system, a drop of dye in a liquid soon spreads throughout because that is the most disordered state. This law states essentially that disorder is more likely than order and so must sooner or later prevail. It is unlikely that all the gas molecules in a box will assume an ordered state and move to the left side of the box, so if it starts out that way the gas will eventually disperse equally. Physics calls disorder entropy, and the second law that entropy increases over time predicts that maximal *disorder* is the expected *end-state* of our universe. In the dismal vision of physics, the universe will end in a big freeze thermal equilibrium where everything disperses like the gas in the box, to be say one atom per cubic light year, after which nothing will change, forever! How wrong to say what they cannot know as certainty!

5.6.4. Creating order

The opposite of entropy is order, maintaining an unlikely state like an unbroken egg despite the flux of life, and indeed the entire earth is a complex web of order that somehow maintains itself despite changes like weather and errant asteroids. At first, physics saw the order of the earth as a *local anomaly*, an accident that bucks the universal trend because:

> "… . *eventually all these over densities will be ironed out and the Universe will be left featureless and lifeless forever, it seems"* (Barrow, p191).

Yet the cosmos is also ordered, as planets orbit stars that orbit galaxies that orbit super-clusters, where each order depends on the one after. Life on earth is only possible because the sun keeps its planets in order and the solar system is only possible because the galaxy keeps its stars in order. Clearly the earth isn't a local anomaly. Bacteria survive in space, so statistically the odds are that millions of planets in our galaxy have some form of life[14] and a galaxy full of life isn't what the second law predicts after 14 billion years of devolving. If *everything always goes downhill*, why aren't we well on the road to oblivion?

A better answer was needed, and so arose the big lie that the big bang was *very ordered*:

> *"The ultimate source of order, of low entropy, must be the big bang itself. ... The egg splatters rather than unsplatters because it is … the drive toward higher entropy … initiated by the extraordinarily low entropy state with which the universe began."* (Greene, 2004) p173-174

In this classic example of reverse logic, *assuming* the second law is true, the initial chaos *had to be* very ordered[15]. To an impartial observer, that the current cosmic order *devolved* from an even more ordered initial chaos makes no sense at all. The alternative now considered is that the second law is not the only principle at play.

---

[13] Murphy's law, that if something bad can happen it (eventually) will, extends the second law of thermo-dynamics to society. Its opposite is Adam's law, that from bad things come good.

[14] The chances of *sentient life* existing *at this time* that has *technology* is far less. Dinosaurs were on earth for a galactic cycle (200 million years) but had no technology to respond to a SETI like probe.

[15] In the classic story, a New Yorker asked why he always yelled replied "To keep the tigers away!". When told there are no tigers in New York he replied "See, it works!".

In quantum realism, matter evolved when the first light collided into electrons and quarks that then formed the first Hydrogen atom, that then fused into higher elements as stars formed. The evolution of physical matter, which is ongoing today, led to the biological evolution that created us. It is now suggested that evolution is the universal principle that opposes the second law, i.e. that increases order and decreases entropy in the universe.

5.6.5. The evolution principle

A clockwork world must eventually wind down but virtual worlds run as long as processing is provided. In our universe, that quantum processing creates constant flux underlies the second law, that disorder increases. The quantum change that drives the second law also underlies the quantum law of all action, that everything physically possible happens at the quantum level, which in turn allowed physical evolution. It is very unlikely that two light rays with extreme photons in every channel will meet exactly head-on, but by this law it must have happened, and when it did the *matter glitch* hung the system in an endless reboot. The second law breaks things apart but evolution creates what survives, like matter.

Evolution as the creation of combinations that increase order isn't just about biology. When extreme light formed into matter, the photons involved reduced their choices so order increased. When electrons and protons formed into atoms choice again reduced so order increased again. The second law focuses on what is *probable* but evolution focuses on what *stable*, e.g. if a salt shaker is shaken each grain will *probably* fall leaving it empty but what if a very unlikely combination of grains blocks the hole? If the result is *stable*, then this is another possible end-state. In this view, physical evolution is forming combinations that survive. That extreme light formed into matter is not yet agreed, but there is no doubt that:

1. Stars evolved into galaxies.
2. Stars and planets evolved into solar systems.
3. Lower elements evolved into higher ones.
4. Archaea and bacteria evolved into the first cell (Lane, 2015).
5. Cells evolved into higher life.
6. People evolved societies.

These evolutions *require* energy so by the second law they shouldn't happen, but they did. The initial chaos tried every option and *matter evolved* not because it was likely, but because it was stable. Atoms evolved because protons and electrons are more stable together. Stars fused lower elements into higher ones that survived to form proteins that reproduced and in turn formed cells that ultimately gave sentient life like us. Evolution, the synthesis of order, is all around for all to see, except for those blinkered by mechanistic thermo-dynamics. Our universe is evolving not dying as physics claims.

5.6.6. Rolling up the universe

General relativity lets space curve locally but is space curved overall? A positively curved universe will eventually stop expanding and shrink back in a *big crunch*, or a *big bounce* scenario where the universe explodes then implodes forever. In contrast, a negatively curved universe expands faster and faster as there isn't enough mass to stop it. Space as the inner surface of an expanding hyper-bubble predicts a slight negative curve and indeed cosmology measures find that the expansion of space is accelerating not slowing down (Cowen, 2013).

If the expansion of space is accelerating will it do so forever? If our universe is an expanding hyper-bubble in a quantum bulk, there are probably others so they must eventually meet. If our

universe meets another matter bubble it will merge with it, but what if it meets an anti-matter bubble? In our universe, gravity is all powerful because it only *adds*, as nothing can oppose it. One can block a charge but nothing opposes gravity so it reigns supreme. Matter does have an anti-matter opposite that could shield from gravity and would *fall up* on earth[16] but our universe took the path of matter so there isn't any anti-matter around. Yet if our matter universe meets an anti-matter one both will annihilate back into the quantum bulk. Even if this has already happened, we would not know until perhaps after millions of years, without warning, our physical universe will be packed away at the speed of light to return from whence it came.

5.7. REDEFINING PHYSICS

The era of finding simple equations like $E=mc^2$ is over. Today's equations fill books because the low hanging fruit of physics have been picked. A better tool is needed to pick the higher fruit and that tool is computer simulations. Yet while one can guess equations that work from the data, developing a simulation requires understanding.

5.7.1. Grounded physics

When Europeans first discovered China its culture made no sense in bible, king and country terms. It could only be understood on its own terms, by making ideas like "keeping face" real. The scientific name for this approach is called grounded theory, and it is to first observe with an open mind, *then* theorize. Anthropologists enter a new culture, watch, listen and record, *then* form a theory to test next day, iteratively, until they understand the culture on its own terms. Letting the data speak first avoided colonial bias but seemed to reverse the usual predict-test method of science, until Kuhn's analysis revealed that science has *two* phases (Kuhn, 1970):

1. *Paradigm growth:* Theory predicts new data.
2. *Paradigm shift:* Data implies a new theory.

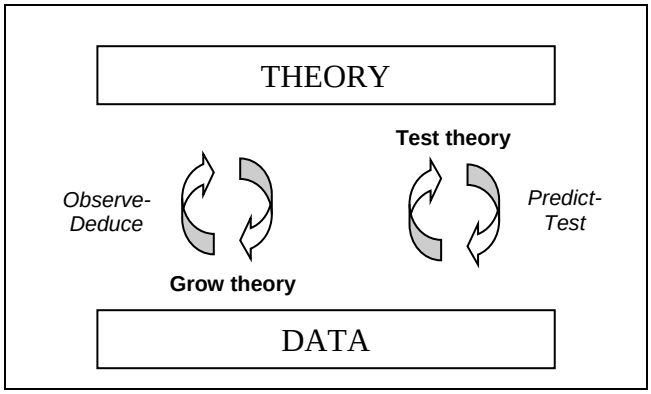


Figure 5.11. Paradigm shifts grow theories

In *paradigm growth*, theories that predict data grow, while in *paradigm shift* data grows an entirely new theory. The first is slow and steady, as water wears away a river bed over years, but the latter is often sudden, as an earth-quake changes the landscape in a short time. In the history of science, established theories dominate until an intellectual earthquake raises a new theoretical landscape from the data ground. Science can be predict-test *or* observe-deduce (Figure 5.11).

The grounded theory of computing is called *reverse engineering.* It involves observing outputs to deduce processing causes that are tested by further interactions. So reverse engineering physical reality to deduce quantum processing is an established method in science, well known in computing and social sciences. Yet physics has approached quantum theory like colonials in China, calling imaginary what doesn't conform to its tradition. The physical realism

[16] If sustained, to avoid the anti-matter first annihilating the matter around it.

culture handed down from Aristotle is as embedded in physics as King and Country was in colonial Britain. The way forward in both cases is a paradigm shift, to see things in a new way.

Last century, physics invented an amazing theory, a tale of quantum waves spreading at light speed that collapsed instantly to a physical event when observed. It made no sense because no physical wave could do that, but it worked brilliantly! So physics decided to *calculate* quantum waves that spread, superpose, collide, collapse and entangle in physically impossible ways while at the same time *denying* those waves existed at all! This began the current era of fake physics, of equations that work based on theories that don't. No-one noticed that quantum theory was an excellent description of how processing waves spread and restart on a network.

Quantum waves can *spread*, *superpose*, *collide*, *collapse* and *entangle* in impossible ways because they are processing waves. Processing on a network can spread waves that *superpose* when they overlap, *collide* when they overload, *collapse* when they reboot at a point, and *entangle* when the restart merges processing. That quantum waves are processing waves also explains relativity. Matter as a standing quantum wave "moves" by *restarting* at a new point, so space and time change when matter moves as each restart loses a time cycle and a pixel of length. Quantum realism uses the equations of physics to define the quantum processing engine.

5.7.2. From nothing to everything

Figure 5.12 summarizes this model. It begins with the *null program* of space that sets a circle of values with no net result, which we call "nothing". Distributing this circle gives the sine wave of light, so the entire electro-magnetic spectrum is one program more or less distributed. In quantum realism, light is essentially space torn apart.

Light as a digital wave has a highest frequency *which* is the null cycle of space half-up and half-down. In the initial chaos, this extreme light collided to give a quantum standing wave, with electrons and neutrinos the one-way collision options and up/down quarks the three-way options. In quantum realism, matter is light condensed.

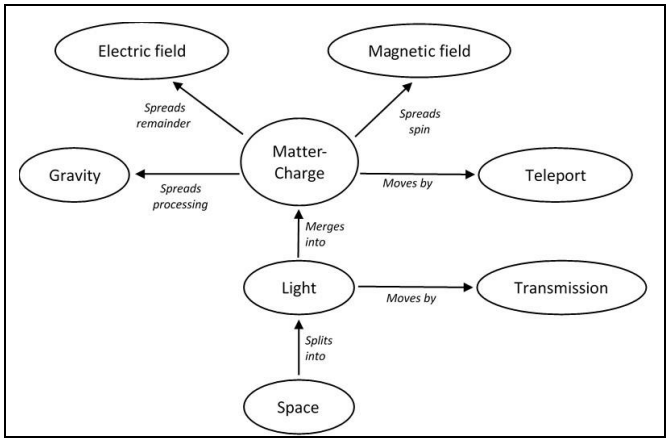


Figure 5.12 From nothing to everything

Matter as a processing overload makes charge the processing remaining, and the electron's negative charge, the neutrino's neutral charge and the curious one-third charges of quarks indeed follow as processing remainders. In quantum realism, charge is what remained after matter was created.

Light moves by transmission but matter as a *quantum standing wave* can only restart at a new point, i.e. teleport. Normally this is symmetric but a photon entangled with matter can bias its natural "jiggle" one way, i.e. move it. In quantum realism, matter moves by teleport while light moves by transmission.

Matter processing on the quantum network naturally spreads as a *processing gradient* that affects other bodies by increasing the load one way to make them overload and restart more often that way. In quantum realism, gravity is a processing gradient that spreads out from matter.

An electric field arises when charge spreads a *remainder gradient* that interacts with other remainders to cancel or add. Between opposite charges remainders cancel, speeding up that part

of the network to again bias restarts to move them together. In quantum realism, an electric field is a remainder gradient that spreads out from matter.

Magnets are when the quantum spins align and this property spreads as a magnetic field that interacts to dilute or concentrate processing on the quantum network. Opposite magnetic poles dilute the processing between them while same poles concentrate it. In quantum realism, a magnetic field is when quantum spins align.

In the beginning, nothing created the initial chaos from which came everything we see today, i.e. *from nothing came everything*.

5.7.3. The end of the beginning

This ends Part I of this book which redefines physics by reverse engineering physical reality. The processing model proposed will be validated as experiments test its many predictions, such as that light colliding created matter, and as simulations based upon it generate more predictions.

Part II, on Conscious Reality, explores the observing "I" and the nature of consciousness from the same perspective.

ACKNOWLEDGEMENTS

Thanks to Kevin Player, Carl Grove, Paul Olivier, Eden Yin, Lucian Ionescu, Marty Wollner, Akram Ben Aissi, Bogdan Lazar, Gayle Dean, Paul Smith, Bruce Maier, Mason Mulholland and Alan Grano. Especial thanks to Belinda Sibly and Matthew Raspanti for edits.

QUANTUM REALISM GLOSSARY

The definitions are based on current physics (CP), computer science (CS) or quantum processing (QP), where the first two are accepted but the latter is a new perspective. References given after an entry are to the chapter section that discusses it in more detail. For the latest see ThePhysicalWorldIsVirtual.com.

Anti-matter. Has the same mass as matter but opposite charge and magnetic momentum (CP) because it is matter processing running in reverse (QP) *(1.3.4)*.

Anti-time. Feynman diagrams show anti-matter entering reactions going back in time (CP) because time passes for matter by forward processing cycles but anti-matter time passes by reverse cycles (QP) *(4.3.6)*.

Asynchrony. When network nodes cycle at their own rate with no common clock (CS). The asynchronous quantum network is synchronized by light transfer interrupts but this method isn't perfect (QP) *(2.5.4)*.

Big bang. If all the matter and energy of the universe began at a dimensionless point (CP) that would immediately give a black hole, so that one photon bootstrapped the universe is more likely (QP) *(1.4.2)*.

Bohr's equation. *E=h.f* states that a photon's energy is Planck's constant times its frequency (CP) *(4.5.1)*.

Boson. An integer spin particle, like a photon or a meson (CP) *(4.5.1)*.

Boson agent. A virtual particle from an invisible field whose effect consumes it so it cannot be seen (CP). Quantum processing explains the same effects without inventing boson agents (QP) *(4.5.2)*.

Breit-Wheeler equation. Describes how photons create mass but is not yet done experimentally.

Casimir effect. Two conducting plates placed close together in a vacuum experience a force pushing them together (CP) illustrating that empty space is not empty (QP) *(2.5.5)*.

Channel. A node channel hosts a photon in a quantum dimension transverse to its polarization (QP) *(4.3.1)*.

Charge. An inherent property of matter (CP) that is the positive or negative processing remaining after each matter cycle (QP) *(4.3.2)*.

Circle of values. See *Null Process.*

Client-server. A network relation that partitions work between a server resource and a client user, e.g. a server document and a client printer (CS) or a photon process and the quantum network (QP) *(5.1.2)*.

Complex dimension. The "imaginary" complex dimension into which light vibrates (CP) that in a processing model is just another dimension of the quantum network (QP) *(3.2.5)*.

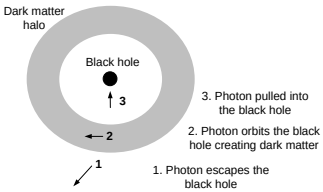
Consciousness. The unalloyed capacity to experience an observation (QP).

Conservation of quantum processing. That the quantum processing generating physical events is constant (QP) *(5.6.2)*.

Copenhagen interpretation. Bohr's 1920 dualism that a physical particle can be a wave so there is no need for quantum reality (CP), but a particle can't be a wave nor can a physical wave be a particle (QP) *(3.3.2)*.

Cosmic background radiation. Early light, once white hot, that is now cold by the expansion of space (CP). It can still be seen all around us because space is spherical (QP) *(2.5.1)*

Cycle rate. The number of processing cycles per second, e.g. a gigahertz processor is a billion cycles per second (CS). The quantum cycle rate is about ten million, trillion, trillion, trillion cycles a second (QP).

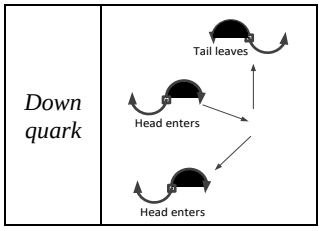


Dark energy. A negative energy that pushes the universe apart (CP) arising because new nodes of space for their first cycle receive processing but don't transmit it (QP) *(4.7.6)*.

Dark matter. Extra matter keeping galaxies together (CP) that arises when light circling a galaxy black hole overlaps to give a mass halo (QP) *(4.7.6)*.

Delayed choice two slit experiment. A two-slit experiment where the measurement is delayed until the light has passed through both slits and still goes through either slit or both (CP) *(3.6.3)*.

Distributed processing. Processing shared that runs slower not less (CS) *(3.3.4)*.



Down quark. The first-generation quark with -1/3 charge and 10x an electron's mass (CP) is a standing wave produced when extreme light heads enter a node as a set of photon tails leave it (QP) *(4.4.2)*.

Dualism. Believing in two realities, such as mind and body *(1.2.2)*.

Dynamic information. The *act* of creating information has no context and can't be stored because to store it is a different act (QP) *(2.2.1)*.

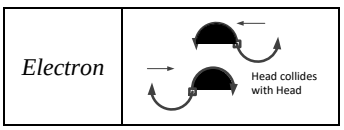
Dynamic processing. The *act* of creating processing (instantiation) has no context and can't be stored because to store it is another act. Dynamic processing gives qubits not bits (QP) (2.2.1).

Einstein's equation. $E=mc^2$ that the energy of matter is mass times the speed of light squared (CP) works because matter is made of trapped light (QP) *(4.4.8)*.

Electro-magnetic field. A single field of electric and magnetic parts that cause each other (CP) makes no sense, but that electricity and magnetism are aspects of matter processing does (QP) *(3.2.2)*.

Electro-magnetic spectrum. All frequencies of light (CP) are one process shared more or less (QP) *(3.2.7)*.

Electron. The lightest elementary matter particle with a negative charge (CP) is a head-head collision of extreme light that fills the channels of a node axis leaving a negative processing remainder (QP) (4.3.1).



Electron shell. Electron atomic orbits that follow the Pauli exclusion principle (CP) can be attributed to the radius, harmonic and orientation of an electron wave (QP) *(4.6.3)*.

Empty space. The vacuum has energy (CP) because null processing cycles aren't nothing (QP) *(2.3.1)*.

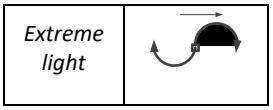
Energy. A physical system's capacity to perform work (CP) reflects its node processing rate (QP) *(3.2.8)*.

Entanglement. Random quantum properties like spin connect at any distance (CP) when merged processing is shared by different locations on the screen of space (QP) *(3.6.5)*.

Entropy. The amount of disorder in a closed system *(5.6.4).*

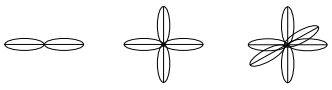
Equivalence principle. The effect of gravity is the same as acceleration (CP) because both increase matter processing (QP) *(5.4.1)*.

Evolution. Trying system combinations to find what survives *(5.6.5)*.



Extreme light. The highest frequency of light, with a wavelength of two Planck lengths (QP) *(3.2.8)*.

Family generations. Electrons, neutrinos and quarks have three family generations each like the last but heavier, then no more (CP) because their photon structures repeat in 3D space (QP) *(4.7.5)*.



Electron generations

Field. A way to explain forces that act at a distance like gravity (CP) that are caused by quantum processing spreading (QP) *(4.5.1)*.

Fundamental particle. A particle not made of other particles (CP) yet still made of photons (QP) *(4.5.6)*.

Gluons. Virtual agents that fit the strong force equations (CP) but don't actually occur (QP) *(4.4.3)*.

Graviton. Virtual agent invented to explain gravity (CP) based on no evidence (QP).

Gravity. The force that draws matter together at a distance (CP) because the processing gradient around a large mass makes other matter more likely to reboot towards it (QP) *(5.4.2)*.

Grounded theory. A scientific method that acquires data *then* forms predictive theories in a cycle *(5.7.1)*.

JIT computing. Just-in time computing is leaving processing decisions until the last possible moment (CP) as quantum processing does (QP) *(3.6.3)*.

Kinetic energy. Energy of movement (CP) is when photons entangle with matter to bias it restarts (QP) *(5.3.3)*.

Higgs particle. The virtual agent that creates another virtual agent that explains neutron decay (CP) *(4.4.6)*.

Higgs field. An invisible field that explains another invisible field that explains neutron decay (CP) *(4.4.6).*

Holographic principle. That everything physically knowable about a spatial volume transmits across the surface surrounding it (CP) is required by a quantum processing model (QP) *(3.6.6).*

Huygens principle. That light is a wave spreading out with each point a new wave source (CP) *(3.3.4)*.

Hypersphere. A four-dimensional sphere (CP) whose inner surface is 3D like our space (QP) *(2.3.4)*.

Idealism. That the physical world is actually a reflection of something else acting on the observer.

Inflation. The brief period after the first event when the universe expanded faster than light (CP) in a chain reaction that made all the free processing of the universe (QP) *(2.5.2)*.

Information. A *physical state* chosen from a contextual set whose value is Log_2N, where N is the number of choices. The information of a state is undefined if the value of N is unknown (CS) *(2.2.1)*.

Instance. A copy of a processing that runs independently (CS).

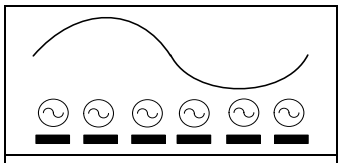
Instantiation. Executing a process from a template, e.g. a screen button instance. A client-server process can instantiate any number of instances that run independently (CS).

Interference. When two or more processes seek the same resource at least one must try again, increasing the processing required. As load increases, interference increases dramatically (CS).

It from Bit. Wheeler's idea that matter comes from processing (CP) is literally true (QP).

Light

Law of all action. That whatever is physically possible occurs at the quantum level, so over time anything that can happen eventually will happen (CP) *(3.4.3)*.



Planck program in many nodes

Law of least action. That the action Nature uses for change is always the least possible (CP) *(3.4.2)*.

Light. A transverse vibration of nothing into an imaginary dimension (CP) is better explained as the Planck program of space distributed over many nodes (QP) *(3.2.7)*.

Little rip. When one node of the quantum network separated to create one photon in one unit of space to bootstrap our universe (QP) *(2.5.2)*.

Many worlds theory. The zombie theory that every quantum choice spawns a new universe (CP) is a physics fairytale (QP) *(3.7.1)*.

Mass. The property of matter that resists movement and causes gravity (CP) is the net processing that repeats each cycle (QP).

Matter. Point matter particles occupy no space so currently have to be kept apart by virtual particles from invisible fields (CP), but matter as processing repeating is separated by quantum network nodes (QP).

Matter distance. The number of photon transfers between two node points for a matter observer (QP).

Matter time. The number of life cycles completed at a node for a matter observer (QP) *(5.3.2)*.

Matter problem. That the mass of a proton is a hundred times more than the quarks that compose it is currently attributed to gluons (CP) but is better explained by processing interference (QP) *(4.7.4)*,

Magnetism. Matter creates a magnetic field (CP) when the quantum spins of its electrons align (QP) *(5.5.3)*.

Measurement paradox. That a quantum wave can't be observed because any attempt to do so collapses it to a point physical event (CP) and the physical world consists entirely of such events (QP) *(3.7.2)*.

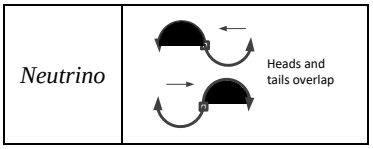
Meson. Transient "particles" with zero-spin that mediate no force (CP) are better seen as matter/anti-matter hybrids whose spins cancel (QP) *(4.7.7)*.

Monism. The belief that there is only one reality *(1.2.2)*.

Movement. A change in spatial location (CP) when light transmits or matter teleports (QP) *(5.3.1)*.

Network density. The number of connections per network node (CS). The quantum network density defines Planck's constant and sets the size of space (QP) *(3.2.10)*.

Neutrino. An elementary matter particle with a variable tiny mass and a neutral charge (CP) that is a head-tail collision of extreme light that cancels but for a slight asynchrony (QP) *(4.3.3)*.



Neutrino asymmetry. Neutrinos always spin left and anti-neutrinos spin right (CP) because their photons only spin one way (QP) *(4.7.3)*.

Neutron. The neutral result when an up quark and two down quarks combine (CP) to share photons in a triangle structure where the processing remainders cancel (QP) *(4.4.4)*.

Nihilism. That nothing really matters so I can do anything I want *(3.7.5)*.

No-cloning theorem. We can't copy quantum states because reading quantum data requires a physical event that alters it (CP) but the quantum network can (QP) (*3.3.4).*

Node. A processing host in a network (CS) or a point in the quantum network that defines space (QP).

Node channel. A photon polarized in one plane passing a point occupies one node channel (QP) *(2.3.9)*.

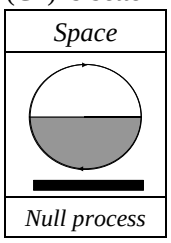
Non-physical detection. Detecting an object without physically interacting with it (CP) *(3.6.4)*.

Nuclear fission. Breaking apart atomic nuclei to release energy, as occurs in atomic bombs.

Nuclear fusion. Joining nuclei to create energy, as when Hydrogen forms Helium in stars.

Nucleosynthesis. The building up of complex matter from simple matter by stars and supernovae *(4.6)*.

Nucleus. The center of an atom made of protons and neutrons that contain nearly all its mass (CP) is better seen as a folding quark string that needs at least one neutron between two protons (QP) *(4.6.1)*.



Null process. An activity with no net result (CS), where empty space is envisaged as a circle of values into quantum space with no net displacement (QP).

Observer. The party that receives information in a reality interaction.

Observer effect. That any observation affects the thing observed (CP) *(3.7.2)*.

Particle. Any energy spike in an accelerator collision however brief is now called a particle (CP).

Particle model. That the universe is explained by 62 fundamental particles with inherent mass (CP) *(4.5.6)*.

Pass-it-on protocol. A network protocol where nodes share processing with their neighbors *then* execute whatever processing they have received (QP) *(2.5.4)*.

Pauli exclusion principle. An after-the-fact rule that opposite-spin electrons can occupy the same point but same-spin electrons can't (CP).

Photon. A polarized pulse of light at one frequency (CP) that is one Planck process over many points (QP).

Physical event. When physical entities interact (CP) their programs overload the quantum network and the reboot merge lets new combinations occur (QP) *(3.3.5)*.

Physical realism. That the physical world is inherently real and the only reality (CP).

Physical state. The result of an observation (CP) is a quantum exchange (QP).

Physical world. The set of observable physical events.

Planar circle. The circle of neighbor connections for a node point plane (QP) *(2.3.9)*.

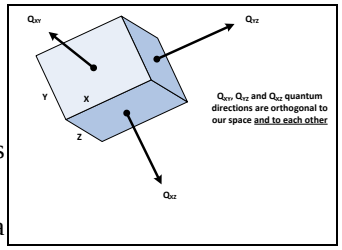
Planck's constant. The smallest unit of energy (CP) is one Planck process per quantum cycle (QP) *(3.2.8)*.

Planck length. The smallest possible length (CP) is that between two quantum nodes (QP).

Planck time. The smallest possible time (CP) is one quantum cycle (QP).

Planck process. Setting a circle of values transverse to space (QP) *(3.2.7)*.

Planck set. The bandwidth of all the channels of a node axis line (QP) *(4.3.3)*.



Quantum dimensions

Plato's cave. People are like prisoners in a cave who take their own shadows on the wall from the sunlight behind them to be real.

Potential energy. Energy that matter has by virtue of its position (CP) is a photon interaction (QP) *(5.6.1)*.

Program. A stored description of processing acts that change information (CS).

Processing. The act of creating or changing information (CS).

Processing gradient. The diminishing strength of matter processing as it spreads on the quantum network (QP).

Processing remainder. The processing that remains unallocated after extreme photons collide to create a matter overload, which we call charge (QP).

Proton. The positively charged result when two up and one down quark combine (CP) to share photons in a triangle structure with positive processing remaining (QP) *(4.4.4)*.

Quantum collapse. Quantum waves restart at a point when observed (CP) because an observation is a network overload that restarts quantum processing at a node point (QP) *(3.3.5)*.

Quantum dimension. A dimension outside space at right angles to any plane through a point (QP) *(4.7.2)*.

Quantum distance. The number of photon transfers between two nodes (QP).

Quantum entanglement. That entities from the same quantum event connect regardless of distance (CP) because they share the same server (QP) *(3.6.5)*.

Quantum field. Quantum processing on the quantum network (QP).

Quantum network. The network that supports quantum processing (QP) (2.1.2)

Quantum paradox. That unreal quantum events cause real physical events (CP) because quantum reality creates physical reality (QP) *(3.7.3)*.

Quantum processing. Dynamic processing that instantiates an entity process in many nodes (QP) *(5.1.2)*.

Quantum randomness. Events like radiation that aren't predictable by any prior physical events (CP) arise from a quantum server with no physical base (QP) *(3.3.6)*.

Quantum realism. The monism that only the quantum world exists so the physical world is virtual *(3.7.4)*.

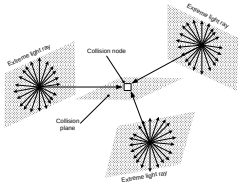
Quantum space. A four-dimensional space defined by the links of the quantum network (QP) *(2.3.8)*.

Quantum spin. The rotation of a quantum entity into a mathematical dimension outside our space (CP) that actually occurs according to quantum realism (QP) *(3.5.3)*.

Quantum state. The numbers that define the probability of a physical event at a point (CP) reflect quantum processing at that point (QP).

Quantum tunneling. A quantum entity can disappear from one point and reappear at another with no possible path between (CP) because matter moves by restarting its processing at a new node (QP) *(5.3.1)*.

Quantum wave. A three-dimensional wave vibrating in an imaginary dimension (CP) can be seen as a processing wave on a network (QP) *(2.3.8, 3.3.5)*.



Quarks as extreme light colliding

Quarks. Up or down elementary particles with one-third charges that cannot exist alone (CP) are the phase options when 3 extreme light rays collide to almost fill the channels of a plane (QP) *(4.4.1)*.

Quark strings. Quarks share photons in closed strings that fold into triangle-based shapes in the atom nucleus (QP) *(4.6.1)*.

Reboot. When a processor restarts its processing from scratch (CS).

Realism. That a reality exists apart from our observation (CP) *(3.7.4)*.

Reality. That which exists outside the observer to cause an observation.

Relativity principle. That the laws of physics are the same to every observer (CP) *(5.2.1)*.

Renormalization. A mathematical trick that makes the infinities of field theory go away if particles interact via other particles, not directly.

Reverse engineering. An iterative method of deducing processing by observing its output (CS). Reverse engineering physical reality aims to deduce quantum processing from physics (QP) *(1.5.2)*.

Science. A way to ask questions of reality that reduces human bias based on the assumption that *we don't know the answers*.

Space	

Space. The 3 dimensions that matter exists and moves in (CP) are quantum network links (QP) *(2.3.7)*.

Speed of light. How fast light can move (CP) is limited by the quantum network transmit rate (QP).

Standard model. A particle-based description using 5 invisible fields, 62 fundamental particles, 16 charges, 14 bosons and 23 data-fitted parameters to explain the equations of physics (CP) *(4.5.4)*.

Standing wave. When waves collide to give a stationary effect (CP) *(4.3.3).*

Standing wave of water

String theory. That one-dimensional strings act in 11 dimensions to give mass and charge particles (CP) needs 10^{500} options to explain anything *(3.2.6).*

Strong force. The force that holds quarks together in the nucleus (CP) can be attributed to quarks orientating to share photons (QP) *(4.4.3).*

Superposition. That a quantum wave can occupy incompatible physical states at once, e.g. two slits (CP) *(3.6.1).*

Teleport. When matter processing restarts at a new quantum node (QP) *(5.3.1).*

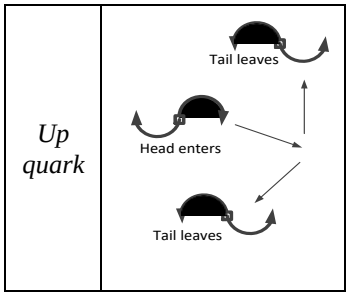
Time. What separates different physical events at the same point (CP) is the number of processing cycles between them (QP).

Transverse circle. The circle of values a photon process sets transverse to space (QP) *(2.3.8).*

Two slit experiment. Shining light through two slits to create an interference pattern (CP) *(3.3.1).*

Uncertainty principle. That one can know a quantum wave position or amplitude but not both (CP) *(3.6.7).*

Up quark. A first-generation quark with plus ⅔ charge (CP) is a standing wave created when photon heads enter a node as two tails leave it (QP) *(4.4.2).*



Virtualism. That physical events are the processing output of some "other" (1.2.3).

Virtual particle. An agent from empty space that mediates a force at a distance (CP) is better explained in quantum processing terms QP) *(4.5.2).*

Weak force. What turns a down quark into an up quark and a neutron into a proton (CP) isn't massive weak particles created by space but neutrino collisions (QP) *(4.4.5).*

Weak bosons. The virtual particles that explain the weak force (CP) are imaginary agents (QP) *(4.4.5).*

WIMPs. Weakly Interacting Massive Particles invented to explain dark matter with no fact base at all (CP).

Young's Experiment. Shining light through two slits to get an interference pattern on a screen (CP) *(3.3.1).*

Zombie theory. A theory that like a zombie has no progeny (predictions) and can't be killed (falsified), e.g. Many-Worlds theory *(3.7.1).*

REFERENCES

Cowen, R. (2013). Universe may be curved, not flat. *Nature News*. https://doi.org/10.1038/nature.2013.13776

Feynman, R. P., Leighton, R. B., & Sands, M. (1977). *The Feynman Lectures on Physics*. Reading, Ma.: Addison-Wesley.

Greene, B. (2004). *The Fabric of the Cosmos*. New York: Vintage Books.

Kuhn, T. (1970). *The Structure of Scientific Revolutions* (Vol. Second Edition, Enlarged). Chicago: The University of Chicago Press.

Lane, N. (2015). *The Vital Question: Why is life the way it is?* (Main edition). Profile Books.

Smolin, L. (2006). *The Trouble with Physics*. New York: Houghton Mifflin Company.

Wilczek, F. (2008). *The Lightness of Being: Mass, Ether and the Unification of forces*. New York: Basic Books.