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 sub-atomic and cosmic domains *yet they contradict each other*, as relativity gives infinities at Planck lengths and quantum field tricks fail for gravity. Two *theories that contradict can't both be right* and this schism exists at the heart of physics today as it did last century. The graviton proposed in 1955 has not been found, so essentially nothing has changed in over fifty years. Quantum theory and relativity conflict because each exposes the other's conceptual baggage but ignores its own:

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

The reconciliation proposed is that *quantum processing* creates both objects and space-time. Last chapter replaced Aristotle's particles with quantum processing and this chapter replaces Newton's space-time canvas with a quantum network, explaining relativity by the same model 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. Today we know that matter is less than 4% of the universe yet particles still rule physics. Physics believes in particles so much that based on *no data at all* gravitons are still regularly shown in the pantheon of standard particles. As another example, a proton's mass is more than a 100x more than the quarks that compose it, which for particles with substantive mass that *adds* is a problem. Where does the rest of the mass come from? The answer in physics today is *always* a particle, so currently the *massless gluons* proposed to explain why quarks bind are said to create it! Now if

[1] For the latest chapter versions see http://thephysicalworldisvirtual.com/

gluon interaction causes 98% of the mass of protons and neutrons, essentially all the mass around you comes from virtual particles that can *never* be seen! 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!

Very few physicists are asking the obvious question - what if Aristotle got it wrong? Matter dominates our earth, but the universe at large consists mainly of space and light. If matter is substantial and space just keeps it apart, how can gluons that create mass come from space?

The alternate view is that matter is the output of quantum processing as a pixel on a screen is the output of physical processing. In both cases, whether something shows or not the screen is always there, so in this view space is "something" in its own right. 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, everything began with the screen we call nothing, followed by the pixels of light that gave the "matter glitch", making matter a distant third in the scheme of things.

In this view, a photon is a *client-server* relation, with quantum processing from a server *instantiated* by the client of space. If there is a client error, it is recovered by a server resend just as when a *client printer* jams it restarts and the *computer server* resends the document. Restarting recovers a client just as we often restart a hung computer to fix it. A server can handle many clients so in the two-slit experiment the photon spreads *client instances* across space to go through both slits at once. When a screen point later overloads the program restarts there and all other instances disappear. What physics calls the *collapse of the wave function* is the disbanding of client instances when the server process restarts.

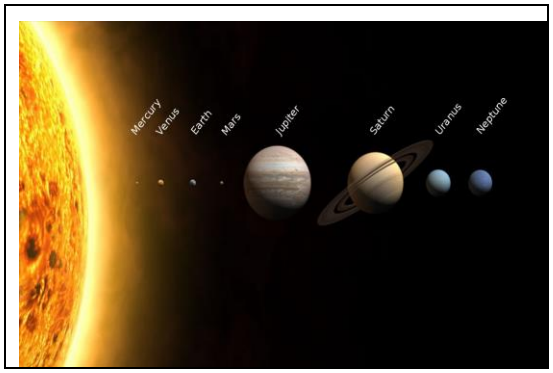

Figure 5.1. *How fast are we moving?*

5.2. SPECIAL RELATIVITY

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

5.2.1. The movement mystery

In Maxwell's equations light is 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?

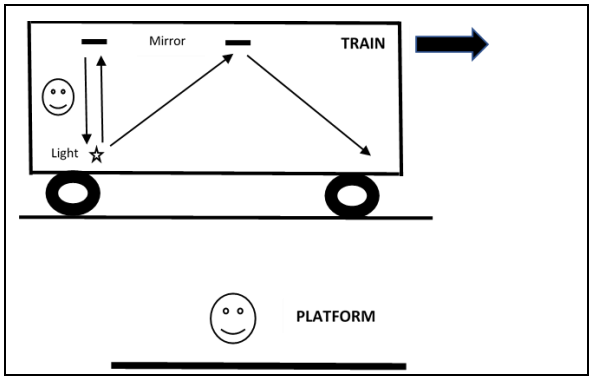

Figure 5.2. Einstein's moving train

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 torch on a rocket gets the same results as on earth.

This is fortunate, because in fact 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 said. 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. If the speed of light varied, torches might not always shine and mirrors might not always reflect! To Lorentz his transformations were a mathematical curiosity but to Einstein they made Poincare's relativity principle work. Time and space changing made physics *invariant*[2].

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! As 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*.

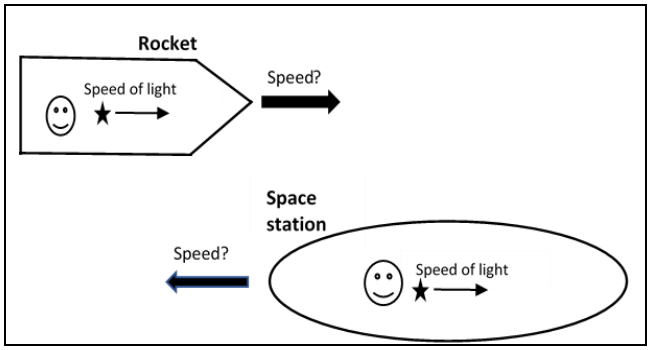

Figure 5.3. A rocket passing a space station

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 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.

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

Einstein didn't say *how* space and time conspire to keep light speed constant, but it isn't for our convenience as Nature doesn't need us to operate. 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 relativity says that for the photon itself no time at all passes[3]. 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.

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 actually travels 3000 meters, i.e. 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!

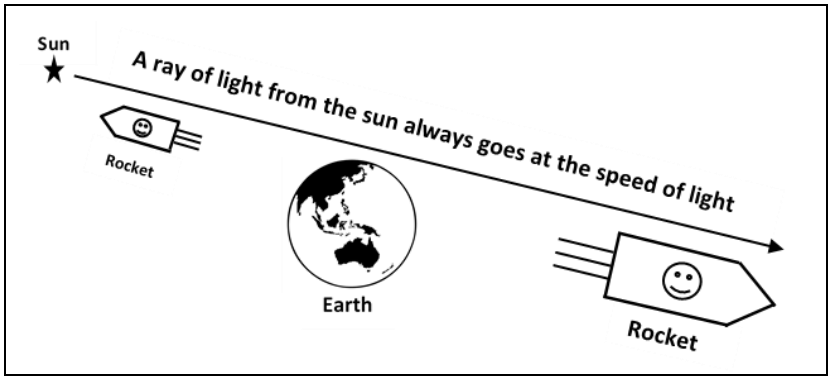

Figure 5.4. A ray of light always travels at the speed of light![4]

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 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

[3] It also starts and ends its journey at the same location by length contraction.

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

throw the ball. One might expect light in the rocket to move at almost twice the speed of light but Nature screws with space and time to keep every reference frame the same.

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, as with quantum theory, is that equations that work make no sense. How can the space that 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 expected that time would unravel the mystery, but 100 years on we are no wiser.

5.3. HOW MATTER MOVES

In this model, matter is processing that repeatedly restarts while light is processing that naturally transmits. Hence it takes energy to *start* matter moving but it takes energy to *stop* light moving. Yet how can matter as an *inherently stationary* standing wave move at all?

5.3.1. Processing bias

By the *pass-it-on protocol*, quantum processing spreads on the quantum network, whether it represents light or matter. So if a photon is like a moving boat spreading ripples behind it, matter is like a stationary boat whose still running engine spreads waves in all directions. A *physical* standing wave doesn't move but a *quantum* standing wave is processing that restarts repeatedly. Matter restarts every quantum cycle and where that occurs depends on the what the network around is doing. 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 load around matter is symmetric its quantum "tremble" *on average* has no effect, which on a macroscopic level we call "stationary". Yet even a tiny bias in the nearby processing that makes it restart one way more than another will move it over time, because quantum events occur at such a fantastic rate[5]. Matter as processing restarting is always quivering. If the processing around it is symmetric the movements cancel out 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 just teleported and in this model, all matter moves this way. Light *transmits* by a path but matter *teleports* directly and this explains the mysteries of special relativity.

5.3.2. Movement changes space-time

According to relativity, as matter moves time and space adjust *exactly* to keep the speed of light constant. This miracle follows directly from this model. If a matter entity restarts one node to the right, any measure *it makes* that way is a pixel less, i.e. distance shortens. Equally if the teleport cycle replaces a life event, then *its* time dilates. Relativity only seems strange if we look only at the pointer and ignore *the observer zero point*. Distance is always measured from where

[5] 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!

one is, so a change in one direction shortens distance that way. And if the teleport interrupts a quantum life cycle it dilates time, because quantum cycles spent on moving aren't spent existing.

The life and movement of matter share a limited quantum resource that can be used for one or the other. As objects move faster they seem to live longer to an outsider but to themselves their life is the same number of quantum cycles. Matter time is measured by the quantum cycles that run in one place and teleport cycles don't count. As light never stays in one place for one cycle, Einstein's equations predict that no *matter time* passes for light, but as quantum cycles still occur *quantum time* still passes.

If matter loses a point of distance and a cycle of time each time it teleports nearby, the speed of light will remain constant *for it*. In Figure 5.4, *the same photon* passes a rocket speeding to the sun and one speeding away from it at the same speed of light but it doesn't change as it passes the rockets. That matter alters their time and space, as Einstein said, follows directly from this model.

5.3.3. Kinetic energy

In this model, the radiant energy of a photon is how much quantum processing transfers per cycle, where the total processing of any photon is Planck's constant, the unit of energy exchange. Kinetic energy as energy of movement seems unrelated to radiant energy, but when photons hit a solar sail it moves so the two must relate, and the basis of this is now proposed to be photons.

If a matter entity as many photons entangled acquired one more that would increase its processing one way making it restart more often that way, i.e. move. So when photons hit a solar sail, it is reasonable to assume the photons entangle with the matter to make it move. If kinetic energy is when matter acquires photons, radiant energy and kinetic energy have the same basis.

How can matter acquire extra photons? Family generations 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 work the same way. As more photons make an object move faster they compete more giving 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.

When a moving body hits another, the photons of its kinetic energy are passed on. At the quantum level, kinetic energy is a photon exchange just as radiant energy is. In current physics, energy is an abstract that is conserved but in this model it is photons that are conserved.

5.3.4. Bit-shifting reality

In an objective world, there is one type of movement but virtual worlds always have two. In Figure 5.5, 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. So it is interesting that our reality also has two movement types, that of light which is absolute and that of matter which is relative to a frame of reference. Light and matter move

differently for us, as in a virtual reality. Light is like a pixel crossing the screen while matter is like a center-screen image with background scrolling. When moving in a fast car or plane it isn't hard to imagine we're still with the world scrolling by because perhaps it is in fact so.

To Aristotle, substantial matter existed at every point on its movement path but in this view a pixel "moving" is really just recreated at sequential points. A screen dot recreated at one point after another seems to move but actually each point is a new event unrelated to the last so *nothing really moves*. When movies show one image after another we see movement but again nothing really moves. An image rapidly recreated seems to permanently exist but it doesn't. When electrons hit each other those that go in seem to come out, but the electrons that exit are new off the quantum press not related in any way to what went in. Quantum "particles" seem to continue but they actually don't. The electrons in and out look the same because the same process made them not because there is any matter "substance" there.

Figure 5.5. *Avatars in a forest*

When a computer briefly shows a pixel at a set of sequential points a "particle" seems to move, but really there is no particle, only pixel events. Likewise, what physics calls particles are quantum waves creating consistent physical events, each of which appears for a moment then disappears forever. Quantum events create physical events as quantum theory says, so as your hand moves matter seems to exist but at the quantum level there no substance, only processing. The physical world is "empty" in the sense that it is a series of quantum images with no inherent substance that constantly exists.

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 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 also 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 in the universe distorts the space-time around it as gravity. Newton's space was the fixed stage upon which events unfolded, but Einstein's matter told space how to curve and space told matter how to move. 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 is a space-time distortion that redefines what it means to move in a straight line.

5.4.2. The gravity 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 still found it *inconceivable* that inanimate matter caused it. Einstein attributed gravity to space-time distortions but didn't explain how inanimate matter was able to alter space and time. Physics today still believes, as Newton did, that only *particles cause forces* so when electro-magnetism occurred in photon units it decided that *virtual photons* from space itself did it. Since the equations worked no-one argued, and so began the practice of inventing virtual entities to explain equations that worked. To invent a virtual particle one only needed an equation that worked and an accelerator event that matched one of its terms, so last century physics devised equations to fit the facts and cherry-picking accelerator events to match. One force resisted this trick, gravity, and that failure casts doubt on all the other virtual agents.

In this model, the virtual bosons of current physics are magical causes invented after the fact. The same facts are better explained by quantum processing and we now apply this approach to 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 flux reduces as an inverse square with distance[6] (Figure 13) giving a *processing gradient*.

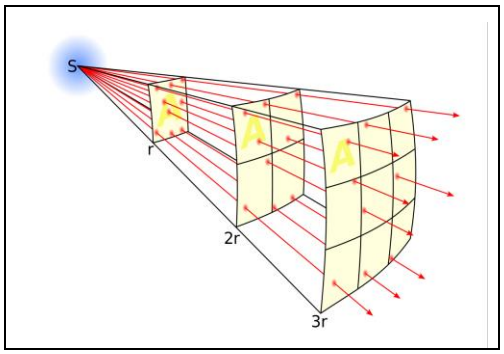

Figure 5.6 *Gauss's flux law*

This processing gradient moves matter by altering the processing distribution around it. If the quantum network on one side of a body has a higher load it will overload more often so on average the body restarts more often that way, i.e. moves. Matter doesn't move because it is pushed but because the probabilities of its ongoing restarts are no longer symmetric. The nature of mass is to constantly overload and restart so if the local network has more processing one way, it restarts more often that way. The processing gradient from a large mass like the earth moves nearby bodies by altering the processing load around them. Each restart entangles it with the earth so it acquires *photons* from the earth in that direction. If that body then hits another those photons transfer as kinetic energy. Matter accelerating constantly adds photons and a body falling to earth increasingly acquires photons from the earth as it falls, so gravity is equivalent to acceleration because the same quantum means causes both.

The search for the graviton failed because a processing gradient has no least quantity. Each photon a mass acquires is a quantum of gravity, but its effect can divide among a mass of any size, and so gravity isn't quantized.

5.4.3. Gravity bends light

Einstein deduced that gravity bends light by imagining a torch shining in a lift accelerating upwards (Figure 5.7). As the lift rises the light curves relative to it, so if gravity is like acceleration it should bend light. Light should "fall" by gravity just as matter does, and indeed light passing the sun is bent, but how can inert matter reach out to move massless light?

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[6] 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.

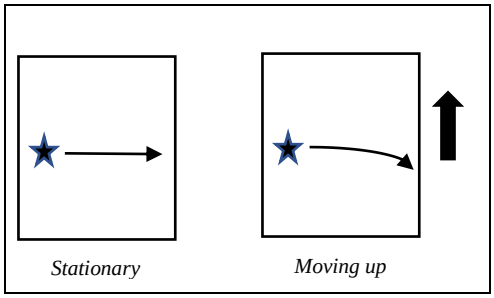

Figure 5.7. *Light bends when moving up*

In processing terms, matter bends light as it does matter, by altering the processing around it. Light spreads as processing transmitted in every direction. If it passes the sun, the greater load nearer to the sun slows down transfers that way so the wave front bends, just as in refraction light slowed down by water bends towards it (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. Since different planets are *not* moving at the same speed, time passes differently on each, so time on the moon passes differently from on earth because its mass is different. Time slows down near a large mass like the earth because its gravity gradient increases the processing load around it making the quantum network cycles take longer. A lot of relativity 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.

All this weirdness makes sense if time passes for matter when quantum cycles complete. Speed alters time because a movement teleport interrupts a life cycle, so matter loses time as it moves. Time dilates because a matter cycle can be a life cycle *or* a movement teleport, but not both at once. Likewise, earth's gravity slows time because it spreads a processing gradient that slows down quantum cycles the closer you get, and more processing means quantum cycles take longer. A bigger mass with more processing dilates time more, so could one live longer on a bigger planet? It would seem so to others, but the number of quantum cycles *experienced* in your life would be the same, so it wouldn't feel so to you. The strange behavior of time in our physical reality implies that time is virtual, as how else can it vary so?

5.5. CHARGE AND MAGNETISM

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

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

All matter arises from a processing overload and charge is the positive/negative processing remaining. This remainder also spreads as an inverse square *electric field* that also comes from matter processing spreading 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 the remainder takes time to pass on. Between opposite charges, spreading remainders cancel and the network works faster so when many nodes overload the faster ones get a program restart from the server more often. Opposite charges attract by speeding up the quantum network between them to increase restarts that way. In contrast for opposite charges the remainders cumulate slowing down the network between them. Charge, like gravity, works by altering the quantum network around a mass to bias its restarts. Two factors affect where a matter body restarts:

- *Whether* quantum network nodes overload.
- *Which* quantum network nodes overload first.

Gravity moves matter by changing the first while charges move charges by changing the second, with the latter more powerful. Gravity biases the *processing load* while charge biases the *cycle rate*. Charge only affects charge because the interaction causes the effect. In this model, gravity and charge both come from the quantum processing of matter.

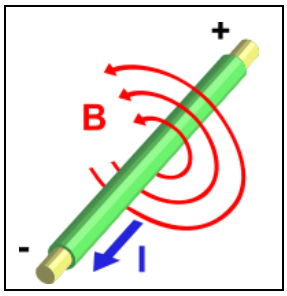

Figure 5.7. *Current I creates magnetism B*

5.5.2. Electro-magnetism

Magnetism was once thought to be separate from electricity until the same equations were found to describe both. So light was said to be an electric vibration sustained by the magnetic vibration it creates, but it isn't possible for two forces to mutually cause each other! Yet how can magnetism have a processing cause when all the processing of matter, as its mass and charge, is accounted for? The answer is quantum spin.

A static charge isn't magnetic but when it moves a magnetic field appears around it (Figure 5.7), 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 that in turn creates electricity is another paradox that current physics just accepts.

Some say magnetism is charge in another guise[7] 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."*
>
> The Feynman Lectures on Physics Vol. II Ch. 13: Magnetostatics

[7] 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.

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

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.

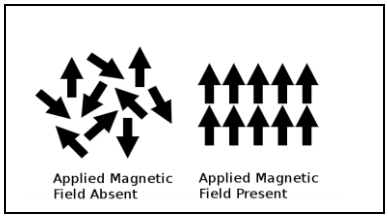

Figure 5.8. *Magnets combine*

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 5.8), 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 so it can't spin, but this model'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 rotations.

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

As matter processing spreads mass and charge on the quantum network, it also spreads spin. When electron spins align there is a magnetic field, so *magnetism* should relate 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 this model, it reflects that opposite spin electrons occupy different parts of quantum space, but same spin electrons occupy the same part. Recall that an electron must rotate twice[8] to return to the same state (4.7.2), so if one electron spins clockwise and another spins anti-clockwise *at the same point*, they never overlap. In contrast same-spin electrons at a point compete for one space that only one can occupy. The Pauli exclusion principle follows directly from this model's description of quantum space.

A magnet spreads matter processing whose spin is aligned on the quantum network, so in between opposite magnets opposite spin means processing can occupy the same space so cycles finish faster. This causes movement as charge did, by biasing the restarts of magnetic matter. In contrast, processing between same poles has to occupy the same space so cycles take longer. Magnetism as spin is a matter processing interaction that affects how *processing distributes* on the quantum network. Opposite magnets dilute processing between them so they attract, and same magnets concentrate processing between them so they repel.

Spin also explains the properties of magnetism. 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

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

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 when electrons as one-dimensional matter move their *matter axes* must point in the movement direction. Electrons align their matter axes to create electricity which aligns their spins, giving magnetism. A current creates a magnetic field because electrons moving align their spins. Conversely, when a magnet moves the magnetic field changes at right angles to a line from the magnet so electrons to move that way as a current. The properties of magnetism can be attributed 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[9]. Gravity required one-dimension, electro-magnetism two, the strong force three and the weak force two. Eight extra dimensions plus the three of space is why string theory needs *eleven dimensions* to work. String theory is a mathematical *description* not a scientific theory because it doesn't predict or add value, and that a universe of eleven dimensions somehow collapsed into ours is far-fetched.

In this model, 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, so is like a flickering image that "jiggles" every frame, so any bias in the processing nearby turns this natural quantum movement into macroscopic movement. Matter spreads a processing gradient that biases the quantum network as *gravity*. Charged matter spread 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 moving anyway, not because virtual particles made it move. These fields act at a distance because matter as processing is not confined to a location nor is it inert or static. Since all come from the mass, charge and spin of matter one could talk of a *gravito-electro-magnetic* field, but it is simpler to talk of 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?

[9] Mathematics calls these dimensions degrees of freedom.

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 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 a closed universe should conserve energy overall. Yet our universe is also expanding, so every photon in it has a bit less energy now than it did a moment ago because its wavelength has increased. The first light 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 wasn't conserved.

The coldness of cosmic background radiation challenges the he idea that we live in a closed system, as a system that expands *into* something can't be closed, nor can it have a constant energy because to expand requires energy. That our universe expands means that *energy isn't universally conserved*. The expansion of space is the exception that breaks the rule. 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 change as inflation 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 began, inflation made a finite number of photons that since then have remained constant. Our universe **is** 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 is not conserved in nuclear reactions and quark flavor is not conserved in weak interactions. Quantum realism replaces all the above by the *conservation of quantum processing*: that in any physical interaction the total quantum processing is always conserved[10].

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

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 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[11].

The second law of thermodynamics states is the formal reason why eggs don't "unbreak". It is that *disorder* always increases for a closed system, so a drop of dye in a liquid soon spreads throughout because that is the most disordered state. This law is essentially that disorder is more likely than order and so it will sooner or later prevail. It is unlikely that all the gas molecules in a box will at the same time 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 is that as entropy increases over time, so maximal *disorder* is the expected *end-state* of our universe. Its dismal prediction is a big freeze, a 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!

5.6.4. Creating order

The opposite of entropy is order, maintaining an unlikely state like an 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. The first response of physics to the order of the earth was to call it 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 very 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. So the earth is no local anomaly. Since bacteria survive in space, millions of planets in our galaxy may have some life[12] 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 it is 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."* Brian Greene *The Fabric of the Cosmos* page 173-174

In this classic example of reverse logic, *assuming* the second law the initial chaos *had to be* very ordered, but that the current order *devolved* from an initial chaos that was ordered makes no sense. The alternative is that the second law is not the only thing at play. In this model, matter evolved as the first light combined into Hydrogen that combined into higher elements in stars by fusion. This physical evolution was followed by biological evolution that took the next steps to

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[11] 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.

[12] 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.

sentient life including us. It is now argued that evolution as a universal principle opposes the second law by increasing order and decreasing entropy.

5.6.5. The evolution principle

A clockwork world will eventually wind down but virtual worlds run as long as processing is provided, and in our universe quantum processing is quite simply always provided. That it never stops gives the quantum law of all action, that everything physically possible happens at the quantum level. The quantum change that drives the second law also drives 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 makes what survives like matter. When extreme light formed matter the photons involved reduced their choices so order increased.

When electrons and protons formed atoms choice again reduced and order increased. The second law focus is what is *probable* but the focus of evolution is what *survives*. If a salt shaker is shaken each grain will probably fall leaving it empty, but what if grains form an unlikely combine that blocks the hole? This end-state is possible if elements that fall alone don't fall when together. In this view, evolution is forming combinations that survive, such as:

1. Stars evolving into a galaxy.
2. A star and planets evolving into a solar system.
3. Lower elements evolving into higher ones in stars.
4. Archaea and bacteria evolving into the first cell (Nick Lane).
5. Cells evolving to higher life.
6. People evolving modern societies.

All the above combinations *require* energy so by the second law shouldn't happen, but they did. The initial chaos tried every option and *matter evolved* not because it was likely but because it survived. Protons and electrons tried every option and *atoms* survived. Stars fused lower elements into higher ones that survived. Elements in turn formed proteins that survived, that in turn formed cells that reproduced, ultimately giving 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.

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*, in 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. In this model, space as the inner surface of an expanding hyper-bubble has a slight negative curve and indeed cosmology measures find that the expansion of space is accelerating not slowing down, so will it expand forever?

If our universe is an expanding hyper-bubble in a quantum bulk, there are probably others and 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 gravity and would *fall*

up on earth[13] but our universe took the path of matter so there isn't any 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 is rolled up at the speed of light to go back 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 for higher fruit and that tool is computer simulations.

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 understand 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 [4]:

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

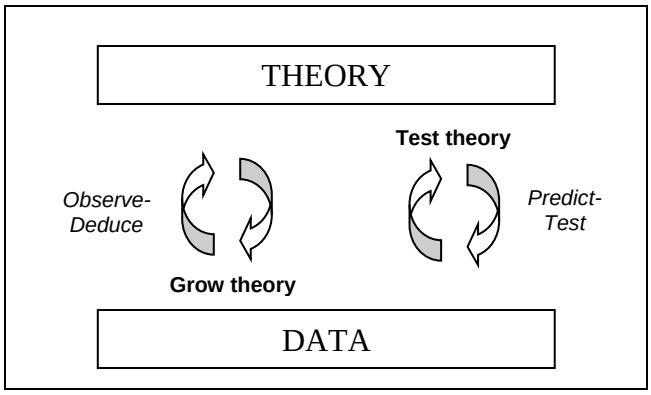


Figure 5.9. Paradigm shifts grow theories

In *paradigm growth* a theory that predicts data grows while in *paradigm shift* data grows an entirely new theory. The first is a 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 5.9).

The grounded theory of computing, is called *reverse engineering*. It involves observing outputs to deduce a processing model that is tested by further interaction. 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 tradition. The culture of physical realism handed down from Aristotle is as embedded in physics as King and Country was in colonial Britain. The way forward in both cases is 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 *calculated* quantum waves that spread, superposed, collided, collapsed and entangled in physically impossible ways, then denied

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

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 *spread*, *superpose*, *collide*, *collapse* and *entangle* in ways that aren't possible physically but are possible digitally. Processing on a network can spread waves that *superpose* as they overlap, *collide* when they overload, *collapse* to a node point that reboots, 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 node, so space and time change when matter moves as each restart loses a time cycle and a pixel of length.

5.7.2. From nothing to everything

Figure 5.10 summarizes this model, which essentially derives everything from what we currently call nothing. It begins with the *null program* of space that sets a circle of values with no net result. Distributing this circle gives the sine wave of light, so the entire electro-magnetic spectrum is the one program more or less distributed. Light derives from space.

Light as a digital wave must have 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. Matter derives from light.

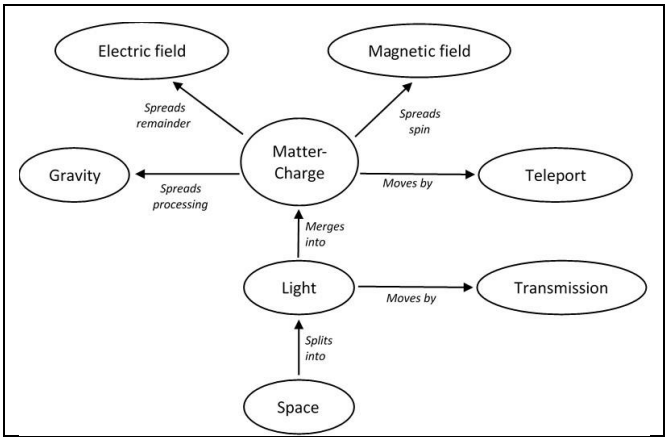


Figure 5.10 From nothing to everything

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. Charge derives from matter.

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. Matter moves by teleport not 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. Gravity derives 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. Electric fields derive from matter.

Magnets arise when the quantum spins of matter align, and this property spreads a magnetic field that alters processing on the quantum network. Opposite magnets attract by diluting the processing between them giving faster cycles and attraction. Magnetism derives from matter.

In the beginning what we might call the void created the initial chaos from which came what we see today. This ends Part I, the reverse engineering of physical reality, whose validation will be by experiments colliding light and simulations. Part II explores the nature of conscious reality.

ACKNOWLEDGEMENTS

Thanks to Kevin Player.

QUANTUM REALISM GLOSSARY

Here are definitions based on current physics (CP), computer science (CS) and quantum processing (QP), where the first two are accepted but the latter is new. For more 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 for anti-matter 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*, that the energy of a photon 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)*.

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) is in a processing model just another dimension of the quantum network (QP) *(3.2.5)*.

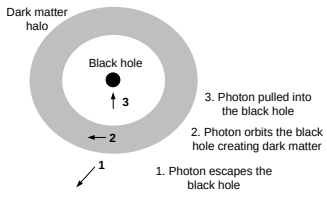
Consciousness. The unalloyed capacity to experience an observation (QP).

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).

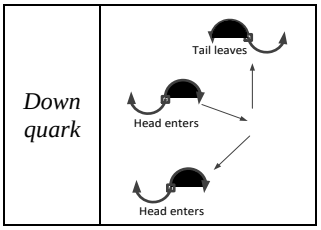


Dark energy. A negative energy that pushes the universe apart (CP) arising because new nodes of space for their first cycle receive processing but don't transmit it (QP) *(4.7.6)*.

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)*.

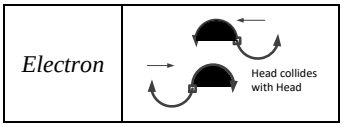
Dynamic information. The *act* of creating information has no context and can't be stored because to store it is a different act (QP) *(2.2.1)*.

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) worksbecause matter is made of trapped light (QP) *(4.4.8)*.

Electro-magnetic field. That a single field of electric and magnetic parts 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)*.

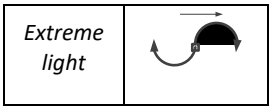
Energy. A physical system's capacity to perform work (CP) reflects its node processing rate (QP) *(3.2.8)*.

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)*.

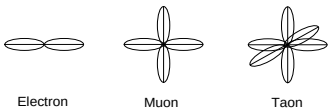
Equivalence principle. The effect of gravity is the same as acceleration (CP) because both increase matter processing (QP) *(5.4.1)*.

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 whatsoever (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 better seen as 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).

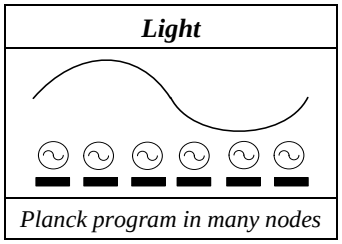
Interference. When two or more processes seek the same resource at least one must try again, increasing the processing required. As load increases, interference increases dramatically (CS).

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

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)*.

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)*.

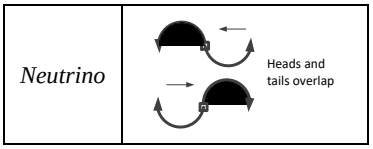
Meson. Transient "particles" with zero-spin that mediate no force (CP) are better seen as matter/anti-matter hybrids whose spins cancel (QP) *(4.7.7)*.

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)*.

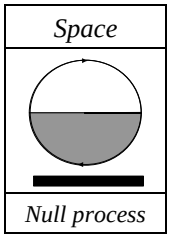
Nucleus. The center of an atom made of protons and neutrons that contain nearly all its mass (CP) is better seen as a folding quark string that needs at least one neutron between two protons (QP) *(4.6.1)*.

Null process. Processing with no net result (CS), where empty space is quantum null processing (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).

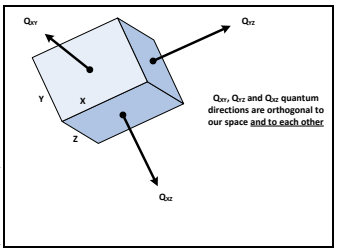
Planck time. The smallest possible time (CP) is one quantum cycle (QP).

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)*.

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)*.



Quantum dimensions

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

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

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 creates processing (QP).

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).

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

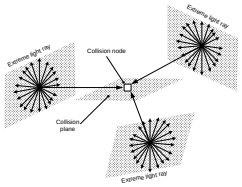
Quantum space. A four-dimensional space defined by the links of the quantum network (QP) *(2.3.8)*.

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 by assuming you *don't know*.

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

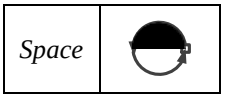
String theory. That one-dimensional strings act in 11 dimensions to give mass and charge particles (CP) needs 10^{500} options to explain anything *(3.2.6)*.

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).

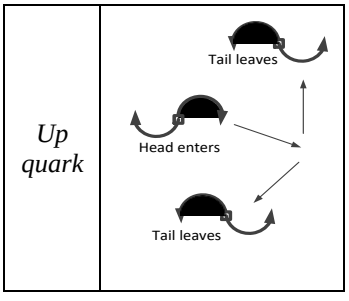


Transverse circle. The circle of values a photon process sets transverse to space (QP) *(2.3.8)*.

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)*.