Chapter 5. The Quantum Field

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

Galileo Galilei

The standard model specifies *a particle cause for every physical effect*, so the action of gravity at a distance is attributed to gravitons, the strong force to gluons and the weak force to W bosons. The result was *many fields* as each new particle needed a new field to produce it but another long-term goal of physics is *field unification*, to reduce all the fields of physics to one field that split into many as the universe cooled. Clearly, inventing many fields contradicts the goal of field unification, as one can't reduce the fields of physics to one by constantly inventing new fields for every effect.

In contrast, quantum realism proposes that only one field, *the general quantum field*, causes all effects, so it supports physics but not the standard model. This chapter explains how the quantum field that explains the electromagnetic, strong and weak fields also explains gravity, electricity and magnetism.

5.1. GRAVITY RULES

Everyone knows that gravity attracts but how does a lump of matter like the moon cause tides on the earth from hundreds of thousands of miles away? Gravity rules the universe at large, but exactly how simple matter changes space and time to cause gravity remains a mystery.

5.1.1. The great divide

About a hundred years ago, relativity and quantum theory replaced Newton's 200-year-old paradigm with a world of malleable time, curved space and quantum waves. A century of research has confirmed both theories in their respective cosmic and sub-atomic domains yet *they contradict,* as relativity gives point infinities and quantum field tricks fail for gravity. As one physicist says:

> "*Mankind has uncovered two extremely efficient theories: one that describes our universe's structure (Einstein's gravity: the theory of general relativity), and one that describes everything our universe contains (quantum field theory), and these two theories won't talk to each other.*" (Galfard, 2016)

This schism lay at the heart of physics last century and nothing has changed since. It is as if the universe has two different rule books, one for the very small and another for the very large, with nothing in common. In a nutshell, the rules for the very large don't work for the very small and the rules for the very small don't work for the very large.

Two theories that contradict each other can't both be right but quantum theory and relativity have been proved right innumerable times so rather than being wrong, both seem to be incomplete. If both are right, then each is only half the picture and something more fundamental is at play.

Quantum realism suggests that these two theories contradict each other because *each exposes the theoretical assumptions of the other but ignores its own*:

1. *Quantum theory:* Assumes that quantum states evolve on a *space and time background* that is fixed (Smolin, 2006), but relativity assures us that it isn't so.
2. *Relativity theory:* Assumes that *foreground objects* follow fixed trajectories, but quantum theory assures us that it isn't so.

This leaves physics with two grand theories, one about how foreground entities act on a *fixed* space and time background and the other about how space and time changes affect *fixed* foreground entities, with no commonality at all.

Quantum theory can't replace relativity because it assumes a fixed background of space and time and relativity can't replace quantum theory because it assumes that particles follow a fixed path. The reconciliation now explored is that the *quantum field* changes *both* foreground objects *and* their space and time background, where the quantum field is defined as quantum processing on a quantum network. If the quantum field causes matter, space and time, it can explain relativity as well as quantum theory.

5.1.2. Matter changes space and time

Space and time are defined in physics by standard rulers and atomic clocks. If objects try to occupy the same space at the same time they collide and the standard model claims that *matter only moves when other matter hits it*. But gravity ignores this rule because it lets the sun hold the earth in orbit even though they are millions of miles apart with nothing between them but space.

Einstein's answer was that matter can change *space and time*. *Special relativity* lets moving matter alter its own time and space and *general relativity* lets large objects change time and space for objects around them. The equations work but they don't say how matter changes time and space and Einstein made no suggestions as to how matter changes space and time.

The standard model doesn't help because space and time aren't particles and it has no particle that can alter space or time. Can a painting make the frame it presents within larger or smaller? Can a movie make the projector running it go faster? Current physics has no answer to the question *how does mere matter change the time and space it exists within?*

5.2. SPECIAL RELATIVITY

Quantum theory is certainly strange but to my mind relativity is stranger because how time and space change is harder for us to understand than quantum waves. Special relativity suggests there is a mystery behind the movement of ordinary matter.

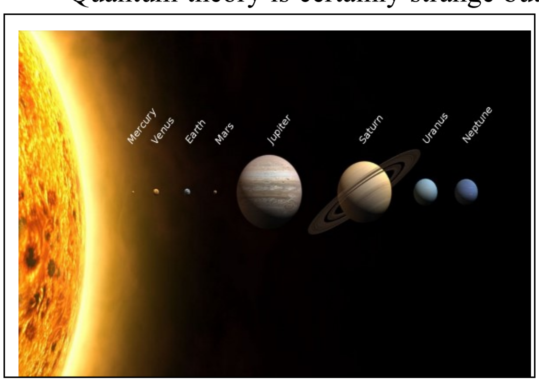

Figure 5.1. *How fast is the earth moving?*

5.2.1. Our reality bubble

Maxwell's equations describe light as a wave so in the nineteenth century a superfine *ether* was assumed to propagate it in space. If the earth orbits the sun to give the seasons and spins to give night and day, the *ether wind* can't always be stationary (Figure 5.1), so the speed of light should vary: light going against the wind should go slower and light going with the wind should go faster. Then in 1887, Michelson and Morley found to everyone's surprise that the speed of light was the same in every direction. There was no ether wind! This was deeply counter intuitive – why didn't the earth's movement affect the movement of light?

Later, in 1904, Lorentz showed that the equations of light stayed the same if space and time changed as objects moved and 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 behaves the same as in a stationary car. In our world, constant speed observers see the same laws of physics, so throwing a ball, swinging a pendulum or shining a flashlight is the same on a satellite orbiting the earth at thousands of miles per hour as it is on earth.

This is fortunate because the earth **is** a planetary platform carrying us through the cosmos. Its spin whirls us around at about 1000mph, it goes around the sun at about 66,000mph and around the galaxy at an amazing 483,000mph. Some estimate our speed relative to the cosmic background radiation at about 1,300,000 mph yet science still works on earth as it does in the rest of the universe. *How is our reality bubble maintained despite the fact that we live on a moving planet?*

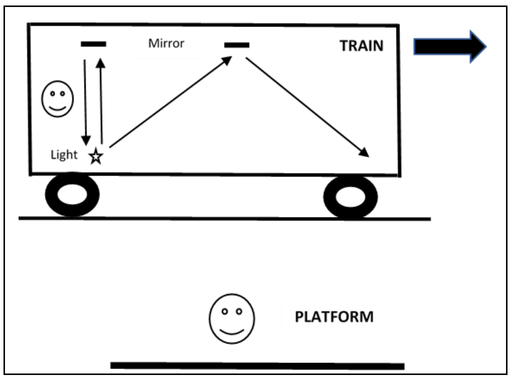

Figure 5.2. Einstein's moving train

5.2.2. Maintaining normality

Einstein analyzed what is necessary to maintain our reality bubble as follows. He imagined a moving train where a floor light reflects from a mirror up on the ceiling. A train passenger sees the light go straight up and down but a platform observer sees it travel a longer path in the same time (Figure 5.2). If time and space are the same for both, they get a different speed of light and different physics. Einstein deduced that space had to shrink and time dilate to keep the speed of light constant. Lorentz saw his transformations as mathematical curiosities but to Einstein they were what made Poincare's relativity work. *Einstein saw that for the universe to be as Poincare described, space and time had to change as Lorentz described*. Space and time had to change to make physics *invariant*[1] or torches might not always shine and mirrors might not always reflect!

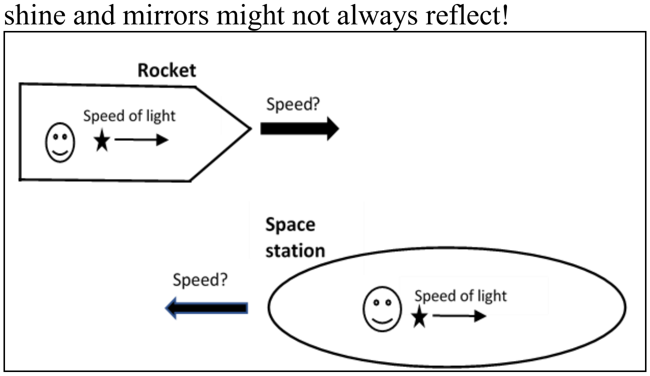

Figure 5.3. A rocket passing a space station

The implications of this are strange indeed. Imagine a rocket flying past a space station in orbit (Figure 5.3). It seems impossible that people on the rocket and on the space station both get the same speed of light, but they do! If they didn't, our physics wouldn't work on Mars.

But who is really moving – is the rocket going past the space station or is the orbiting space station passing 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*

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

change just enough to keep the speed of light the same for both. For a particle model, this extraordinary finding makes no sense at all.

Experiments have verified that time and space change as matter moves. It seems weird that time and space change with speed but as Einstein said, *this is why the universe **isn't** weird*. That the speed of light is constant for all movement is why we appear to live in a "normal" universe.

5.2.3. Maintaining causality

Why is the speed of light constant instead of say, the speed of lead? What makes light the *gold standard of movement?* The answer lies in the role of light in causality. Imagine a rocket going to a planet at nearly light speed and then returning to earth. If the rocket's speed 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 getting a cheery Facebook message from a person after attending their funeral. Relativity keeps the causality given by light messages in the right order.

It turns out that if a rocket could leave the earth faster than light, it could in theory go *back in time to return before it left*. As Buckley points out, given faster than light travel, relativity and causality, the universe can support two but not all three at once. It can't go faster than light because that would breach the causality of events we observe. It doesn't happen because light, the constant messenger of causality, never gets it backwards.

It follows that *light moves differently from matter*. If matter and light moved the same way, then light would need a push to go faster again after it slowed down in water say but needless to say, it isn't so. Light speeds up when going from water to a vacuum with no push needed. In general, it takes work to *move* matter but to *stop* light moving takes work. If I drive at 100mph and throw a brick forward at 10mph, it goes at about 110mph. But on a rocket going at half the speed of light, torchlight goes forward at *exactly* the speed of light! *How does light, and only light, do this?*

5.2.4. Matter has its own time

Relativity says the speed of light is constant because time slows and distance shortens as matter moves faster. In a classic thought experiment, Einstein imagined a twin leaving on a rocket who returns after five years of high-speed travel in space to find his twin brother is an old man of eighty! This could happen because a muon traveling at 99.5% of the speed of light travels 3000 meters when it should travel only 300 meters in its millionth of a second life, so speed extends its life tenfold. Relativity lets in a rocket accelerating at one ***g*** get to our nearest galaxy and back in *60 years* but a traveler would return to find the earth *four million years* older (Harrison, 1986, p157). The evidence suggests that *matter time slows down as matter moves faster* but what does this mean?

For Newton, God "painted" matter objects on a universal canvas of space and time. Einstein replaced this view with equations that we know are true but can't explain. If we keep the analogy, then *what is painted isn't just the object but also its time*. This is hard to imagine, but if the object's time and its movement come from the same finite "painter", increasing one demand by moving an object faster will decrease the other, so time passes slower for faster moving objects because the same finite source gives rise to both. This is what the theory of relativity implies.

According to Einstein's equations, *time stops at the speed of light* so a matter clock on a photon wouldn't tick at all. A photon from the Andromeda galaxy takes 2.5 million years to get here but according to relativity, no time at all passes *for the photon itself.* It also starts and ends its journey at the same location by length contraction! Needless to say, this makes no sense, as how can light move at all if its time stops? The obvious conclusion is that *matter time doesn't apply to light*.

5.2.5. The universal speed limit

Light goes at the fantastic speed of 670 million miles per hour, all the way to the moon in a second. Can we achieve 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 changes time and space so the bullet only goes at four-fifths the speed of light!

What if we gradually accelerate a rocket up to the speed of light? Nature again intervenes by increasing the rocket *mass* until at near the speed of light its near *infinite mass* needs a near *infinite force* to move it. This contradicted the conservation of mass and the law of thermodynamics, that energy in a closed system can't be lost, but 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 was 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. If the rocket had headlights, one might expect light to leave it at almost twice the speed of light but again Nature plays with space and time to keep the speed of light the same.

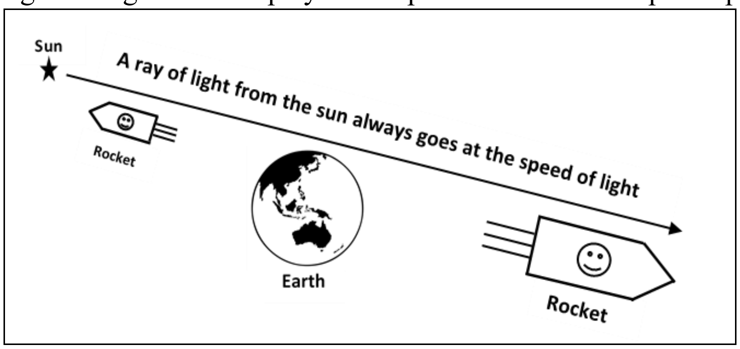

Figure 5.4. Light always travels at the speed of light!

Relativity contradicts all our intuitions about movement. For example, if we sent two rockets from the earth at half the speed of light, one to the sun and one to Pluto (Figure 5.4), relativity requires that light from the sun passes both rockets and the earth at the same speed! How can *the same photon* pass both rockets, one going to the sun and one away from it, at the same speed? This makes no sense in classical or indeed any other terms.

In relativity, as in quantum theory, the equations work but again they don't make any sense. *How can space that is the measure of movement, itself "move"? How can time that is the measure of change, itself change?* It cannot be, yet the evidence we have suggests that it is so.

Einstein *deduced* how space and time had to change for our world to be as it is, but he didn't *explain* it, no doubt expecting physics to unravel the mystery in time but it is now a 100 years later and we are none the wiser! How matter changes space and time must relate to how it moves but the current assumption that inert matter has a natural property of movement offers no clues. What then does quantum realism suggest?

5.3. MATTER TREMBLES

In physical realism, movement is a natural property of matter so there is no reason why it can't just go faster and faster but special relativity is clear that matter can *never* reach the speed of light. Physical realism has no explanation at all for the universal speed limit that relativity describes.

In quantum realism, light is a constantly spreading wave of quantum processing and matter is the same processing as a standing wave that constantly restarts. This explains why light inherently moves but matter is inherently stationary but raises the unexpected question: *If matter is a standing quantum wave, how does it move at all?* Quantum theory suggests that it is because *matter trembles*.

5.3.1. How matter moves

Light moves forward because, as Huygens proposed, it is a wave that spreads at every point, so the front of the wave spreads out before the back of the wave does. The backward spread of the wave front is cancelled by the forward spread of the wave rear but its forward spread isn't, giving a forward moving wave. A quantum processing wave spreading on a network can do this.

In contrast, a standing quantum wave spreads on the network equally in all directions so it has no front or back in any direction. Light then is a moving quantum wave while matter is a standing quantum wave that should be inherently stationary. A photon is like a *moving boat* spreading ripples behind it while matter is like a *stationary boat* whose engine still spreads waves in all directions.

According to quantum theory, point matter entities don't sit at a fixed point but *tremble* about their quantum distribution. Schrödinger deduced this zitterbewegung or "quantum fuzziness" from the Dirac electron equation. Light and matter then act alike in that while a *measurement* locates a photon or electron at a point, in quantum terms they *exist* throughout their distribution. A photon only restarts when measured but electron matter restarts every cycle based on its quantum distribution. A matter point is like a dot that is redrawn each cycle but not at the same point so it appears as a fuzzy patch not a clear point.

Quantum matter randomly trembles based on its distribution. If the distribution is symmetric, there is no *average* movement but if for any reason it is *asymmetric*, it will restart in a particular direction more often. As quantum events occur at a fantastic rate, this adds up to cause macroscopic movement in our time. If the distribution of a point matter entity is symmetric, the trembles cancel but if not, any *restart asymmetry* will give rise to visible movement.

Quantum trembling explains why matter doesn't move as light does. Light moves by node-to-node *transfer* but matter moves by a point restart that is in essence a *teleport*. This movement allows quantum tunneling where an electron within an impenetrable Gaussian field suddenly pops up outside it, like a marble suddenly appearing out of a sealed bottle. It didn't *travel a path* out as light does because it can't exist in the field around it, *it just teleported out*. A quantum matter entity can tunnel to any point in its quantum distribution by restarting there.

If matter moves by teleport not the path transfer of light, how does it change space and time?

5.3.2. How matter changes space and time

If matter moves by teleport, how does that affect time and space? In quantum realism, a photon arrives at a screen as *a cloud of client instances* and the first node overload to successfully restart the photon server is where it hits. Many instances arrive but only one collapses the wave function by restarting the photons server at its point. The photon *spreads* as a quantum wave but is *detected* by a point physical event.

The same applies to quantum matter but its distribution spreads around it in a sphere. Before a physical event occurs, an electron is an *instance ensemble* just as a photon is. But it is many photons constantly restarting in a node and servers restarting at the same time and point *entangle.* They jointly run all the instances distributed around the electron so any successful restart involves them all. As a result, an electron *restarts as an entity* every cycle and where it restarts depends on its distribution, just as for a photon. The electron's ability to restart at a new point allows it to tunnel to a new point regardless of any intervening barriers.

For matter, a "tick" of its time passes for every processing cycle it completes in the same node but each cycle it may also interact with something else. For example, a muon hit by a neutrino decays into an electron, an antineutrino and a muon neutrino. It takes about a millionth of a second for this to happen and this is the *muon's lifetime*.

Now suppose that one quantum cycle the muon restarts at another point so it *moves*. As the distribution around a muon is weaker than at the center, a neutrino strike there won't give a decay. If a neutrino was about to strike where the muon was, moving extended its lifetime by one cycle. By moving the muon dodged the neutrino bullet so the teleport cycle added to its lifetime.

For a muon, life events and movement events share a fixed resource, quantum cycles, that give one or the other but not both at once. A quantum cycle can be *either* a life event or a teleport so as a muon moves faster, more teleports replace life events so its lifetime increases. *Time dilates for the muon as it moves faster* as relativity says.

Any quantum matter entity that spends a quantum cycle "in transit" loses a life event cycle. Restarting at a new point in its distribution stops a life cycle occurring so as matter moves faster, its time dilates. If it restarts one node to the right say, *any measure made in that direction is a pixel less*. If one measures distance from where it is, a teleport one way shortens distance that way, and if time is measured in life events, every teleport steals a life event. *Together, these two effects keep the speed of light constant as matter moves*.

Figure 5.5 shows the space-time diagram of a photon passing stationary matter. The photon moves one point of distance per point of time to give a 45º line, which is the speed of light. Now suppose the matter point moves one unit towards the photon by teleport. If the axes stay as they are, it moves a distance unit closer to the photon in a unit of time but the teleport shifts the axes by a distance unit and a time unit as well. Since the photon still passes through the zero-point, shifting both axes by one means the photon line is still 45º, which is the speed of light. *Relativity arises because matter movement changes the origin of time and space*.

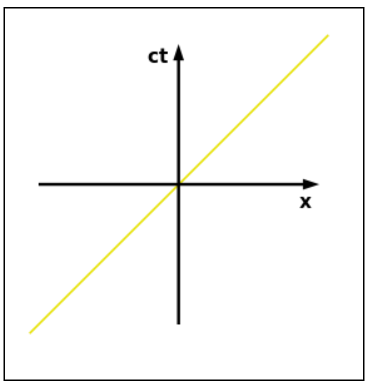

Figure 5.5. *Spacetime diagram of a photon passing a point*

Recall the earlier example where *the same photon* from the sun passes rockets going in different directions from the earth at the speed of light (Figure 5.4). If the rockets and the photon move in the same way this is very strange but they don't, as matter alters its time and space as it moves. The photon doesn't change what it does but each rocket alters its time and space as it moves to keep the speed of light constant.

Each bit of matter has its own *frame of reference,* as if it had its own clock and map. Matter time is *relative* because it changes its reference frame as it moves. In contrast, light moves on every quantum cycle so for it, time passes *absolutely*. For matter to move at the speed of light, it would have to teleport every quantum cycle leaving no time for life events so its time would stop. This isn't true for light because matter time doesn't apply to light*, as time is absolute for light but relative for matter*.

5.3.3. Kinetic energy and photons

Light has *radiant energy* from its frequency but matter has *kinetic energy* from its movement. They seem unrelated but a solar sail moves when light hits it, so radiant energy somehow gives it kinetic energy. If matter is made of photons, then perhaps photons don't just disappear when they hit a solar sail but join with the photons that give it mass.

If an electron point of matter can become a higher generation muon by adding photons, then every matter node has spare channels so all matter can add more photons. If a solar sail acquires photons with one direction, its quantum field will increase one way causing movement that way. If each matter node in the sail reboots every cycle at a random point depending on its quantum field, increasing the field density in one direction will increase the restart probability that way. The result over time is the macroscopic movement of the solar sail in the direction of the photons hitting it. In general, when matter acquires photons in one direction, its quantum tremble will move it that way

That matter moves when it acquires directional photons suggests that kinetic energy is passed on when one moving body hits another because the photons causing the movement are passed on. If kinetic energy arises when matter acquires photons, it has the same basis as radiant energy.

That matter moves by acquiring photons also explains why mass increases as objects go faster. The added photons increase the interference between photons competing for channels that increases the processing that in this model is mass. As more photons make matter go faster, the increase isn't linear because interference doesn't increase linearly with load, as networks like the Internet show. As relativity says, the mass increase tends to infinity as movement approaches the speed of light.

Kinetic energy based on photon acquisition isn't quantized because any mass size can add one photon so the change can divide to any degree. A large mass shares the effect of adding a photon so its *inertia*, or resistance to movement, is more because it takes more photons to move it. *The kinetic energy of matter and the radiant energy of light interact because both are based on photons*.

5.3.4. Bit-shifting reality

An objective world has only one type of movement, that of the object, but virtual worlds always have two. In Figure 5.6, one can move the avatars to the left by moving their pixels left or by moving the forest pixels behind them right. A program can create movement by moving the object or its background as the avatars move *relative* to the forest. Programs can move images by *bit-shifting* the foreground or the background. In the first case, avatar pixels move across the screen and in the second case, the background pixels scroll behind the center-screen object's *frame of reference.*

Figure 5.6. *Pixel avatars in a pixel forest*

Our reality also has two movement types, of light that is absolute and of matter that is relative to its frame of reference. Light and matter move differently in our reality just as in a virtual reality. Light moves like a pixel crossing a screen while matter moves like a center-screen image whose background scrolls. The standard model assumes particles move on a stationary background but relativity describes the option to bit-shift the background. In a fast car, one can imagine being still with the world scrolling by, perhaps because it is actually so.

5.4. GENERAL RELATIVITY

Special relativity explains that being inside a plane going at a constant speed is like being stationary because time and space adjust to keep it so. General relativity extends special relativity to attribute the *acceleration* caused by gravity to changes in space and time as well.

5.4.1. Free-fall is acceleration

When a plane accelerates, the back of the seat pushes passengers to keep up with the plane but parachutists in free-fall accelerate without feeling a force at all. A parachutist jumping from a plane in a *free-fall* feels no force as gravity accelerates them to the earth so as Douglas Adams said:

"*It's not the fall that kills you; it's the sudden stop at the end.*"

But how can matter go faster and faster when nothing is pushing it? Einstein's insight was to link the force of gravity to a free-fall acceleration that equates to being at rest. His conclusion that gravity isn't a force at all but due to the earth curving space and time around it was he said "*the happiest thought of my life!*" He deduced that *the force of gravity is equivalent to an acceleration,* so people in a rocket accelerating at **1g** feel a force pulling them down exactly like gravity on earth. Inside the rocket, they can sit down and have a cup of tea just as they do on earth thanks to gravity. Gravity is indistinguishable from an acceleration *except that no particles "push" matter to make it happen*.

Instead of particles causing the acceleration of gravity, Einstein deduced that the earth warps time and space around it. He replaced Newton's inexplicable force-at-a-distance gravity by a gravity that inexplicably distorts space and time. For Newton, space was the stage on which objects acted in common time but for Einstein, *matter changed the space and time that define movement*. If the earth distorts space and time, particles following straight paths curve as if under the influence of a force. *Einstein's gravity redefined what it means to move in a straight line*.

Centuries earlier, Galileo discovered that but for friction, all masses fall at the same speed because gravity and inertia both increase equally with mass. A heavier object has more gravity pull but it also has more inertia, so the effects cancel. Einstein added that it is so because gravity is an acceleration that varies with mass just as inertia does. It was a brilliant solution but it *left the standard model with a force that none of its particles could explain*.

5.4.2. The gravity gradient

Newton discovered gravity but found it *inconceivable* that inanimate matter caused it:

> "*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

If matter only moves when other matter pushes it, how can gravity move matter at a distance without direct contact? Physical realism had no answer then and it still can't explain gravity today as that *inanimate brute matter* distorts space and time is as inconceivable as that it acts at a distance! Assuming that *only particles cause forces,* physics attributed electromagnetism to virtual photons but this trick didn't work for gravity and Einstein's relativity didn't make it any less magical.

In quantum realism, an electron is a photon ensemble constantly restarting in a network node. This activity creates a *quantum field* around it that lets electrons "tunnel" to places they can't travel to. The earth as a huge bulk of matter creates a huge quantum field around it that has effects far beyond its surface. Passengers in a plane high above the earth sit in seats thanks to gravity and compasses show the earth's magnetic field is there in the plane. Physics attributes gravity to gravitons and magnetism to virtual photons but quantum realism only has the quantum field. It is called an *imaginary existence field* as it defines where matter might exist but in quantum realism it is a *real existence field* that defines where quantum activity exists. In these terms, *matter spreads its existence around itself as quantum processing*.

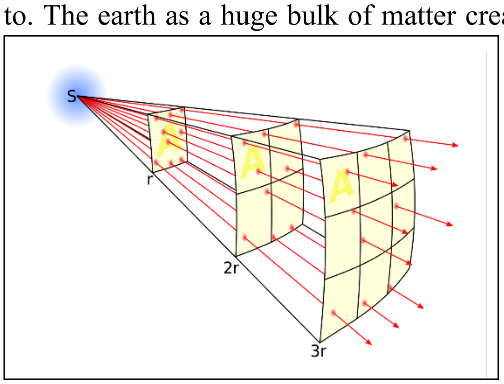

Figure 5.7 *Gauss's flux law*

How then does the earth's quantum field spread? According to Gauss's theorem, any flux spreading out over a sphere surface diminishes as the inverse square of its radius[2] (Figure 5.7) so if quantum processing spreads as a flux, *the quantum field reduces as an inverse square of distance*. The reduction in strength with distance gives a *processing gradient* that can explain gravity.

For a matter satellite orbiting the earth, the quantum field on the side nearer the earth has more processing than the side further away. If every node of matter naturally trembles on the quantum level, increasing the quantum field one way will make it restart more often that way. If each matter entity in the satellite restarts randomly based on the quantum field, increasing the field on one side will make it more likely to restart that way. The earth then moves matter not by "pushing" it but by increasing the quantum field on the side nearer to it so it restarts more often that way.

Classical objects only move when pushed but in quantum theory, an electron can jump to any point in its quantum field without anything pushing it. The earth's quantum field is so massive that its processing gradient makes quantum entities tremble more often one way to cause movement in our terms. *In quantum realism, gravity is the quantum field of a massive body creating a processing gradient that biases the tremble of quantum matter towards itself.*

5.4.3. Gravity and photons

In quantum realism, the earth is a quantum aggregate that spreads it existence around itself to cause its gravity. It in effect *superposes its existence* on the space around it.

Gravity can't be blocked so no anti-gravity shield is possible. If gravitons caused gravity, anti-gravitons could create an anti-gravity shield but no evidence supports this. Likewise, if gluons held the nucleus together, an anti-gluon stream could break it apart but again there is no evidence even though anti-gluons are said to exist. And since a photon of the right phase can cancel another, one could cancel the virtual photons of electricity and magnetism with the appropriate light but again there is no evidence for this. It is more likely that *it isn't possible to block a spreading quantum field by any physical means at all*.

A matter aggregate moves when its quantum parts move. If those parts constantly jiggle, the whole moves when they all take a quantum step one way. This is unlikely but quantum events occur at such a fantastic rate that it will eventually occur if the jiggle of each part is biased one way. Hence matter moves incredibly slowly compared to light.

When an object falls to earth, the earth's quantum field participates in the node overloads that cause quantum restarts so some of the earth's photons are likely to restart in the object. As the body moves to the earth, its mass will then acquire photons in that direction. Matter that constantly acquires photons from the earth superposed around as it falls will accelerate. If kinetic energy is based on photons, *a matter body that continually acquires photons will accelerate.*

Gravity then causes acceleration because its superposed quantum existence around a falling body both causes movement and adds photons to the body to accelerate it. *Gravity is equivalent to acceleration because both have the same quantum cause, namely the acquisition of photons*.

5.4.4. 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 accelerates up, the light curves relative to it, so if gravity equates to acceleration, it should bend light. Light should "fall" by gravity as matter does

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[2] 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.

and light passing the sun is indeed bent. The logic worked but how can matter move massless light at a distance if the standard model has no particle that can push light around?

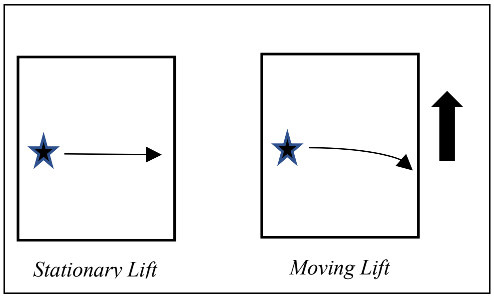

Figure 5.8. *Light bends when a lift moves up*

The sun is so massive that its quantum field fills the solar system to keep planets in orbit far beyond the earth 93 million miles away. A photon passing the sun is a processing wave that moves by spreading in every direction. The processing gradient of the sun that is its gravity also slows down the spread of the photon wave nearer the sun for the same reason that light is bent by *refraction* (3.6.2) when it moves from air to water.

Water has more matter than air so it requires more quantum processing which slows down the node cycle rate to make light move slower in water. If one side of a spreading wave goes slower than the rest, it is skewed that way, so light entering water bends in the direction of the water because it is a spreading wave. In the same way, a photon of light passing the sun is a spreading wave that bends towards the sun because the network closer to the sun runs more slowly. *Light has no mass but it has quantum processing so the gravity gradient of the sun bends it*.

5.4.5. Gravity slows time

The special theory of relativity lets every mass in the universe have its own clock. I have one, you have one and our nearest star has one, so matter only has the same time if it has the same speed. General relativity lets gravity alter time as well, as time slows down near a large mass like the earth. It takes a lot of computing to make satellite navigation work because the clocks of GPS satellites tick at a different rate from the receivers on the ground. If one day people lived on the moon, time would pass faster for them so they would age a tiny bit more because the gravity is less.

If time passes when quantum cycles complete, whatever slows down quantum cycles will slow down time. Gravity as a quantum processing gradient that diminishes with distance slows down the network accordingly so time slows as it increases. The matter of the earth superposes its existence on the quantum network around itself to alter time, so a clock on top of the Empire State Building will run faster than one at the bottom. Gravity slows down time, as Einstein concluded, but it acts on the quantum network not time itself as time is a result, not a thing that exists in its own right.

Would one live longer on a larger planet with more gravity? It might seem so to others but the quantum cycles experienced would be the same. Living on a larger planet stretches time relative to earth but doesn't change the lifetime one experiences.

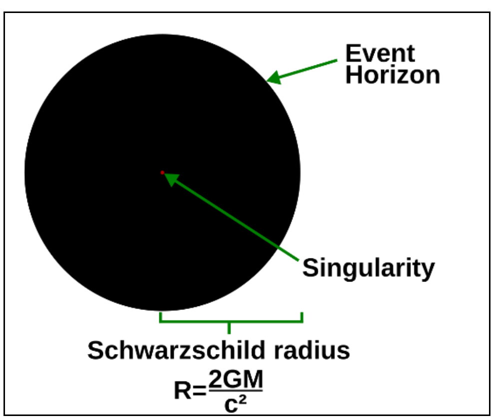

Figure 5.9. *A black hole*

5.4.6. Black holes

The equations of general relativity imply that when a large enough mass collapses under its own gravity, nothing can stop it becoming a *black hole*, a region of space with gravity so strong that not even light can escape from it. It is now believed that nearly every supermassive galaxy, including our own, has a black hole at its center.

Physics has no force to stop the collapse of matter, so a black hole is said to be a point of infinite matter density called a *singularity*. The *event horizon* of a black hole is the region from which nothing, not even light, can escape the pull of its gravity (Figure 5.9). In current physics, a black hole is a singularity of infinite matter density that creates an event horizon around it.

In quantum realism, physical reality is digital so it has no infinities. To say that the equations "predict" a singularity of infinite matter density is to think an equation is a theory. That an equation generates an infinity usually indicates an error not truth. If the matter is quantum processing running on a quantum network, the network has a finite bandwidth of the processing it can handle.

It follows that just as the network has a finite transfer rate that limits the speed of light, it also has a finite capacity that limits the degree that matter can collapse in a black hole. That limit is the *bandwidth of space* that is reached when all the channels of node of space are filled. What stops the collapse of matter in a black hole is a finite limit on how much matter a point of space contain.

This implies that a black hole isn't a matter singularity at all but a volume of space at maximum processing capacity, with no infinity. Adding matter to a black hole then needs more nodes of space, as each node of the black hole is already full. The evidence agrees that larger black holes occupy more volume. Recent theories suggest that black "holes" are in effect black stars, i.e. sources of energy absorption (Barcelo et al., 2009). Note that no quantum processing is lost in a black hole.

In quantum realism, *a black hole merely represents the bandwidth of space*.

5.5. ELECTRICITY AND MAGNETISM

If the gravitational field of the earth arises from the quantum field it spreads around it, what are the electric and magnetic fields of matter? Can one quantum field have three different aspects?

5.5.1. Electromagnetism

Magnetism was thought to be distinct from electricity until Maxwell's equations were found to define both. A static charge isn't magnetic but when it moves, a magnetic field appears around it (Figure 5.10). If you wrap a wire around a nail and pass a current through it, the nail becomes a magnet. The magnetism stops when the current stops, suggesting that *electricity causes magnetism*. And if you wrap a wire round a magnet and spin it, a current is induced in the wire, so by the same logic, *magnetism causes electricity*.

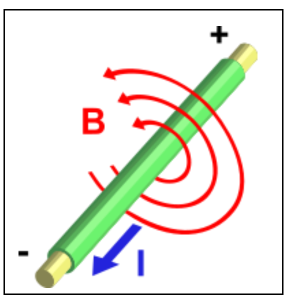

Figure 5.10. *Current I creates magnetism B*

Hence light is said to be an electric field vibration sustained by the magnetic field vibration it creates, yet mutual causation is illogical! That electricity causes magnetism that causes electricity is just another mystery that physics has learned to accept.

Some argue that magnetism is charge in another guise[3] but if so:

1. Why don't static charges and magnets interact?
2. Why is magnetism at right angles to the electric field?
3. Why doesn't Gauss's law apply to magnetism, as it decreases more like an inverse cube than an inverse square?

[3] The argument is that a moving electron's length is foreshortened by special relativity giving more negative electrons than positive protons in a given length of wire, hence parallel wires with opposite currents attract. In quantum realism, this is correlation not causation.

4. Why does dividing a charged body give positive and negative charges but dividing a magnet gives two more magnets, both with a north and south pole?

Magnetism behaves very differently from charge but that Maxwell's equations describe both implies that they are aspects of the same thing:

> *"We will see that magnetism and electricity are not independent things – that they should always be taken as one complete electromagnetic field."* (Feynman et al., 1977)

But that we can explain electric and magnetic fields separately doesn't mean we can explain electromagnetism, any more than explaining horses and birds might explain a winged horse. That the same field can be electric or magnetic depending on reference frame doesn't explain why it has two different effects (electric and magnetic) that have different directions and weaken differently. Some say we don't need to explain if we have equations, but equations aren't theories. *The current situation is that physics has no credible theory of what electromagnetism actually* ***is****.*

It is now said that when charges repel, virtual photons batter them apart and when they attract, virtual photons push them together. Magnetism quite works differently from charge but the same virtual photons are said to cause it as well. *One gets the impression that as long as the equations work, physics would be happy to attribute electromagnetism to fairies with photon wands*.

Quantum realism argues that matter bodies spread their quantum processing, nothing else, so it must derive both electric and magnetic fields from *a single quantum field*.

5.5.2. Quantum remainders spread

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 quantum processing coin, where:

1. *Mass* is the net processing that repeatedly runs to overload a node, and
2. *Charge* is the processing remainder left over after the overload.

As all quantum processing spreads on the network by the pass-it-on protocol, the remainder must also spread. If the spread of net processing causes gravity, how does the spread of the charge remainder affect the quantum field?

If a quantum network node first passes on *all* its processing, its quantum cycle has two phases:

1. ***Share phase***: Pass on all current processing to neighbor nodes:
    a. *Cancel*: First, cancel any positive/negative processing.
    b. *Share*: Then, share <u>all</u> the net processing left among neighbors.
2. ***Execute phase***: Run all the processing received from neighbors:
    a. *IF a node overloads*: Request a restart from the server(s) involved.
        i. *If ignored*: If no server response, drop the job.
        ii. *If accepted:* Restart processing from the server(s) as a *physical event*.

As concluded, gravity arises when the processing gradient around a massive body alters the *execute phase* of nearby matter, to make it overload and restart more often one way. In contrast charge, as a processing remainder, affects the *share phase.*

For bodies with opposite charges, the remainders cancel so the nodes between them have less processing to pass on. For same-charge bodies, the remainders add so the nodes between them have more processing to pass on. It is expected that nodes with less processing to pass on finish the share phase sooner, making their quantum cycle faster.

As a result, the quantum field between opposite-charged bodies runs faster but between same-charged bodies it runs slower. Each charge creates a *remainder gradient* around itself that *interacts* with other charges to alter the *quantum network cycle rate*. For opposite charges, that the quantum field runs faster between them makes quantum restarts occur more often towards each other so they move that way. The macroscopic attraction we see is the average effect of a quantum restart bias. For same charges, the quantum field between them runs slower so the effect is repulsion.

The charge remainder gradient reduces with distance to have a negligible effect on a neutral body, just as its gravitational effect is negligible, but when it interacts with another charge gradient, the effect is noticeable as opposite or same charges attracting or repelling. Unlike gravity, charge is based on the *interaction* between charges affecting the quantum field.

Gravity biases the quantum field *load* but charge interactions bias the quantum field *cycle rate*. In both cases, a *quantum field bias around matter makes it move*. Matter bodies restart every cycle, so if the nodes on one side of a charged body run faster than the other, they get server access *first* to restart more often that way, making charged bodies move together or apart.

Gravity and electric fields work differently because where matter restarts depends on:

- *Whether* the quantum network overloads, where gravity causes a *load gradient*.
- *Where* the quantum network overloads *first*, where electric field interactions cause a *rate gradient*.

Both effects arise because quantum processing spreads on the quantum network, and they reduce as an inverse square by Gauss's law of flux. Physics sees the effect of a quantum field *load gradient* as a gravity field and the effect of a quantum field *rate gradient* as an electric field, but the same field causes both. They manifest differently because mass and charge are different properties of matter but *electric fields come from the quantum field as gravity does*. How then does magnetism fit into this model?

5.5.3. Quantum spin spreads

The other basic property of quantum matter, along with mass and charge, is quantum spin. We know that dividing a magnet gives two small magnets and joining two small magnets gives a big one. If big magnets come from smaller ones, all magnetism must trace back to the smallest possible magnet, which in physics is an electron.

Metals become magnetic when their electron magnets align the same way. If electrons align randomly the net effect is zero but if they align the same way, the metal becomes magnetic (Figure 5.11). In contrast, the electrons in plastics aren't free to align so they can't be magnets. *Magnetism occurs when electrons align.*

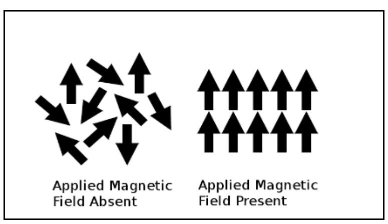

Figure 5.11. *Electrons align to give magnetism*

An electron is essentially a tiny magnet whose north pole is at right angles to its spin and its south pole is the opposite way. Spin is an inherent property of quantum matter, like mass and charge, *so all quantum entities spin*. In current physics, spin is imaginary because an electron as a point particle can't spin but in quantum realism, an electron has a structure that spins in quantum space. Either way, quantum spin relates directly to magnetism and *matter becomes magnetic when its electrons align their spin in the same direction*.

A positive-negative body splits into positive and negative parts but instead of splitting into north and south parts, a magnet splits into two more magnets, each with a north and south pole (Figure 5.12). An electron, the tiniest magnet, also has a north and south pole even though it is a point particle that can't split into parts.

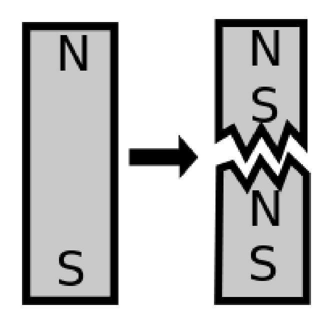

Figure 5.12 *Splitting a magnet gives two more magnets*

A spinning electron has north and south *directions* not *parts*. If quantum spin creates a magnet, then north and south poles are *directions* related to spin, suggesting that a north pole can't exist without a south pole, just as a plate with an up direction always has a corresponding down direction.

If spin causes magnetic poles, a single pole can't exist but the standard model touts a magnetic monopole, an elementary particle of one magnetic pole. No evidence exists for magnetic monopoles but they are another fruitless standard model search, like WIMPS, squarks and gravitons.

In this model, an electron as one-dimensional matter *rotates* about its matter axis. Recall that an electron must do *two 360° turns to spin once*. If electron spin was in physical space, a matter axis rotation wouldn't alter it but as noted earlier, quantum space allows three additional orthogonal directions to give two more rotation planes through any axis. As electron spin occurs in all possible directions, it also spins in these planes *so an electron needs two turns to spin entirely*.

The Pauli exclusion principle lets opposite-spin electrons exist at the same point but not same-spin electrons. It *describes* an observed fact but quantum realism explains *why*. If two electrons at the same point spin in opposite ways, the first turn takes them into different parts of quantum space and the second turn does the same, so if one electron spins "up" and another "down" at the same point, *they never overlap*. In contrast same-spin electrons at the same point compete for the same quantum space that only one can fill. *Quantum space explains why opposite spin electrons can exist at the same point but same spin electrons can't.*

In this model, the quantum processing of matter spreads spin on the quantum network, as well as mass and charge, so it creates a *spin gradient* around itself. If same magnets spread the same spin and opposite magnets spread the opposite spin, by the Pauli principle, same magnets interact to *concentrate* the quantum field while opposite magnets interact to *dilute* it.

Like charge, one magnet alone has little effect on neutral matter but for two magnets the spins *interact* to alter the quantum field between them. For opposite magnets, it *dilutes* as opposite spin electrons don't overlap while between same magnets, it *concentrates* as they use the same quantum space. The expected effect is to slow down the quantum network between opposite magnets and speed it up between same magnets, and this causes movement as for charge.

A magnet alone doesn't move because the quantum field around it is the same in all directions. But add a same magnet nearby and their spin gradients interact to slow down the quantum field between them so same magnets repel because they restart less often towards each other. In contrast, an opposite magnet nearby speeds up the quantum field between them so they attract because they restart more often towards each other. It follows that *same magnets repel and opposite magnets attract due to an interaction between their spin gradients that we call magnetism*.

Electric and magnetic fields then relate because both are based on electrons. If *electricity* is electrons moving as matter, their *matter axes* must align in the movement direction for it to happen. If electrons align their matter axes to move as electricity, they also align spins to give magnetism at right angles, as the spin plane directions are at right angles to the matter axis. Electrons moving one-way spin one-way but moving the other way spin the other way. A current creates a magnetic field because electrons align spins when they move. Equally, when a magnet moves, the magnetic field changes at right angles to a line from the magnet making electrons move that way as a current.

Attributing magnetism to the spread of quantum spin also suggests why magnetism disperses faster than charge, as while charge spreads in two dimensions by Gauss's law, magnetism spreads in a more complex way into three dimensions.

In quantum realism, charge remainders interact to speed up or slow down the *share* cycle of the network between them and magnet spin directions interact to speed up or slow down the *execute* cycle. In both cases, the effect is to bias the quantum field to cause matter to move.

5.5.4. There is only one field

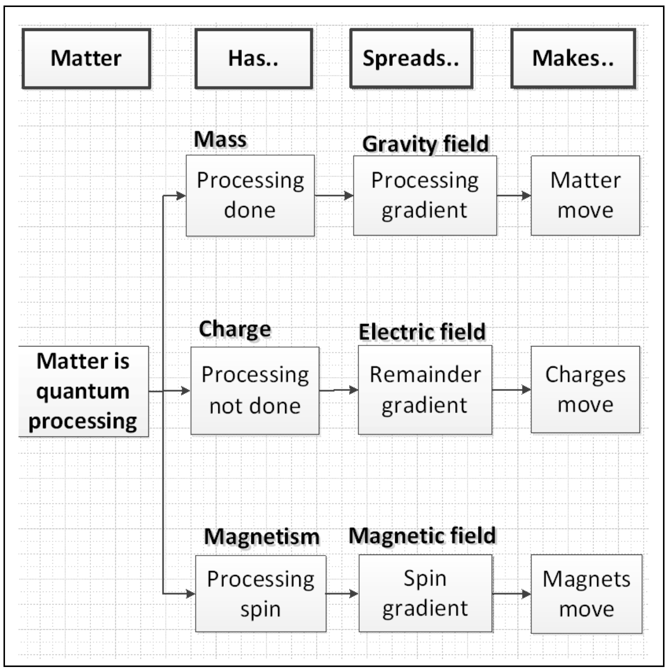

Figure 5.13 Quantum processing spreads to make matter move

Quantum processing spreading on the quantum network gives one quantum field that causes electromagnetic strong, weak, and gravity effects. In Figure 5.13 matter *mass* spreads as processing done, *charge* as processing not done and *magnetism* as processing spin, to cause:

1. *Gravity*. A processing gradient that weakly biases the quantum field *load* around all matter.
2. *Electricity*. A remainder gradient that interacts with other charges to bias the quantum field *rate* around them.
3. *Magnetism*. A spin gradient that interacts with other charges to bias the quantum field *rate* around them.

In each case, matter moves when a quantum field bias makes its quantum tremble occur more often one way, to eventually give movement in our time. One must push inert matter but quantum matter constantly moves based on its quantum distribution, so all that is needed to move it is a bias in the quantum field around it. *Quantum processing spreading causes matter to move at a distance*.

It follows that the fields of physics move matter by biasing its natural tremble not by invoking virtual particles from nowhere to push it. A *gravitational field* spreads a processing gradient that biases the quantum field load around matter. An *electrical field* spreads a remainder gradient that biases the quantum field rate around charges. A *magnetic field* spreads a spin gradient that biases the quantum field rate around magnets. These fields act at a distance because quantum processing spreads on the quantum network and matter moves when it trembles more often one way.

Quantum realism links electromagnetism to gravity which no other theory does. We could call gravity, charge and magnetism the *gravito-electro-magnetic* field, but the *quantum field* is simpler.

5.6. CREATING ORDER

According to physics, the universe constantly increases disorder not order. The second law of thermodynamics is that every closed physical system tends to increase *entropy,* the technical term for disorder. If the physical world is all there is, our universe is a closed system that must always increase in disorder because energy is conserved. It follows that its end state will be one of *maximal disorder,* of maybe one atom per cubic light year in a *big freeze* that will last *forever*!

The problem is that this theory doesn't predict the universe we see today:

"*Scientists have often been baffled by the existence of spontaneous order in the universe. The laws of thermodynamics seem to dictate the opposite, that nature should inexorably degenerate toward a state of greater disorder, greater entropy. Yet all around us we see magnificent structures—galaxies, cells, ecosystems, human beings—that have all somehow managed to assemble themselves*." (Strogatz, 2003)

If the universe is always increasing disorder, how did fourteen billion years of degeneration give the order we see around us today? That is like waking up in a warm bed with an electric bed lamp and being told that civilization has been in constant decline since we lived in caves.

The usual answer is that the order around us is local, as the second law lets a local order exist if it pays an energy price. A fridge can keep a beer cold on a hot day by electrical energy but if the power shuts off, the beer warms up as the fridge unfreezes. A local order can only be sustained by an energy input because heat energy spreads and energy is always conserved, but is this true?

5.6.1. Is energy conserved?

Thermodynamics began as the study of *energy* in the form of *heat.* It was observed that in a closed system, heat always flows from hot to cold but the total heat is constant. The second law of thermodynamics is the generalization that the universe is closed system with a constant energy that always disperses.

However, physics also has *potential energy* based on *position* in a gravitational field. 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?

For example, if a rocket is shot into earth orbit, where the liftoff energy goes isn't seen. If it leaves the earth and travels in space forever, presumably its potential energy is stored forever. If it crashes on a bigger planet like Jupiter to release more energy than leaving earth took, where does the extra energy come from? Energy is conserved if objects stay in the same place but they never do, so is potential energy just a way to cover up any discrepancies?

Those who explain physics say that energy is conserved because if the Jupiter rocket was re-assembled and returned to earth, the energy would be restored. But how can future options explain the present? Applying that logic to entropy, does an egg broken on the floor have potential entropy because it can be reassembled again? One would ask, where is this potential entropy stored? So is potential energy stored in space, matter or gravity itself? *Current physics can't say*.

Most energy transfer has a *means,* so when a car loses kinetic energy to friction its tires become hot and radiate heat energy, so we can observe kinetic energy turning into heat energy. In contrast, a ball thrown up loses kinetic energy to where? With no means of exchange, potential energy is just a way to say that energy is conserved when it isn't. *What then is always conserved?*

5.6.2. The universal conservation

If energy isn't created or destroyed, a closed system should have a constant energy so if the universe is closed, its energy should be constant. But it isn't that simple as in an expanding universe every photon now has a longer wavelength than it did a moment ago and so has less energy than it did before. The cosmic background radiation that was once white hot is now freezing cold because expanding space took its energy and *didn't give it back,* so the total energy is reducing. A universe expanding into something isn't closed so energy isn't conserved because expanding takes energy.

On the other hand, the energy of the universe is mostly dark energy, which must increase to keep the cosmological constant the same, so the energy of the universe is increasing. Either way, it is very unlikely that the total energy of our universe is constant.

Energy is *locally conserved*, as solar panels, windmills and dams convert radiant, wind and gravitational energy into electricity, but it isn't *universally conserved*. Just as the bank notes in a country might be locally constant but global inflation can reduce their value, so space expanding can alter the value of energy on a universal scale.

If energy isn't always conserved, what is? In quantum realism, our virtual universe arose when the original quantum reality split into the servers and clients that generate it, in what physics calls *inflation.* If this was a once only event, the number of photons in existence has remained constant at a finite number. Expanding space changed energy but not the total number of photons.

If every physical event is a reboot of photons in various forms, as light or matter, photons are always conserved. Current physics conserves matter, charge, energy, momentum, isospin, quark flavor and color but each law is partial, as matter isn't conserved in nuclear reactions and quark flavor isn't conserved in weak interactions. The underlying conservation is that of photons.

If all energy, radiant, kinetic, potential and nuclear, is based on photons then the conservation of energy reflects the conservation of photons. For example, when a solar sail turns *radiant energy* into *kinetic energy,* photons enter the sail and are conserved. Photons also explain potential energy as when a rocket crashes on Jupiter with more energy than the potential energy it took to leave earth, it acquires photons from Jupiter's gravity. Photons are the means that potential energy lacks. *The universal conservation is of photons because everything is light upon light, nothing but light.*

5.6.3. Disorder is probable

The laws of physics are reversible, so reversing a video of earth orbiting the sun breaks no law of physics and looks the same to us. Yet reversing a video of an egg breaking evokes laughter, even though every event in the breaking is as reversible as the earth's orbit. It is common sense that things break apart easier than they come together, so an egg can break in a second but it can't be put back together in a second. The second law of thermodynamics explains why eggs break easier than they "unbreak".

If some colored gas is injected into the corner of a sealed box, by the second law it disperses throughout the box because gas molecules constantly adopt different combinations and those that disperse the colored gas are more numerous than those with the gas in a corner. Over time, the most likely result is that the gas is evenly spread. The colored gas molecules *could* all move back to the corner but it is extremely *unlikely* that they will.

If a lottery machine has balls numbered 1-99, the chance they emerge in the order 1, 2, 3 …99 is astronomically low. A more likely result is a mixed order and the same applies to gas molecules. The second law is based on the laws of probability so it's a *statistical* law not a *causal* law. It isn't that objects *must* become disordered but that they *probably* will. In a constantly changing world, disorder prevails because *order is unlikely*.

Disorder tends to increase because our world constantly changes. As Heraclitus said, *life is a flux,* so it isn't possible to step twice into the same stream. Life isn't the same from one moment to the next because quantum reality constantly generates it anew. The formal principle behind the Heraclitean flux is the quantum law of all action, that at the quantum level anything that can happen does. Disorder increases because quantum reality always tries new things, so *the quantum law of all action underlies the second law of thermodynamics*.

5.6.4. Order is possible

The opposite of entropy is *order* that maintains an unlikely state like an unbroken egg and the entire earth is a complex web of order that somehow maintains itself despite changes like weather and errant asteroids. At first, physics argued that the earth is a *local anomaly*, a random 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, 2007) (p191).

But the order we see isn't just the earth. *The visible cosmos is ordered*, as planets orbit stars that orbit galaxies that orbit super-clusters, and each order depends on the one above. 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. The earth isn't a local anomaly if it derives from a cosmic order. Another suggestion is that the big bang must have been *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 view, the universe began very ordered and is only half-way through its devolution so life is still possible. In this reverse logic, the universe had to begin very ordered *because* the second law is true, but that the *initial chaos* was a very ordered state makes no sense at all.

The fact is that we see order all around us, such as:

1. *Galaxies*. Nearly all stars in galaxies orbit the same way, as any star orbiting another way eventually hits other stars and either leaves the galaxy or is turned around. The common orbit direction of galaxies is an *observed order* that arises because it is stable.
2. *Solar systems*. The planets in a solar system eventually adopt orbits that don't interact. Any exceptions again result in catastrophic events until the system again adopts an *observed order* that is stable.
3. *Atoms*. Hydrogen atoms evolved because electrons and protons together are more stable than either alone, again an *observed order*.
4. *Elements*. The periodic table elements exist because unlikely combinations of electrons, protons and neutrons survived. A lead atom is again an observed *order* that is stable.
5. *Molecules*. Atoms combine into *ordered* molecules if they again are stable.

It follows that *order evolves if it is stable* and life is another example. Life isn't just any old order but a *self-replicating one* that might even spread between planets. Panspermia is the theory that bacteria can hitch a ride on an asteroid, meteor or comet to travel between planets. It is possible because bacteria in boxes placed outside the International Space Station for a year came back to life when they returned to earth. Under harsh conditions, some bacteria form *spores* that are dead metabolically but revive under the right conditions, even after millions of years. If life can evolve on one planet and spread to another, bacteria from Mars may have colonized Earth and millions of planets in our galaxy may have some form of life thanks to bacterial colonists. A galaxy teeming with life isn't what the second law predicts after 14 billion years of decay!

It is now suggested that order is all around us, in nature and the cosmos, because *evolution can create order*.

5.6.5. Evolution creates order

The quantum law of all action causing the second law of thermodynamics also lets evolution select from unlikely combinations because everything that can occur eventually does, but *what drives evolution isn't probability but stability*. It is unlikely that two extreme light rays will meet exactly head-on but when it did, the matter result was stable. A very unlikely event created it so matter exists because it was stable not probable. The quantum law that destroys order also finds unlikely combinations that survive. A lead atom is 82 protons, 125 neutrons and 82 electrons that shouldn't naturally combine, but they did, and the reason is evolution. Lead, with a half-life of millions of years, is an order that exists not because it is *probable* but because it is *stable*.

The quantum law of all action underlies both evolution and devolution, so one can't have one without the other. They work differently, as devolution creates the *probable* and evolution creates the *possible,* but both have the same quantum cause. The second law *generally* decreases order but evolution *locally* increases it, as when an electron and a proton form a hydrogen atom, they move together instead of both being free, so system order has increased. While the fridge needs a constant energy input to stay colder than its surroundings, the order of an atom doesn't need a constant energy supply. *When matter entities combine into a new stable entity, order increases permanently.*

Hydrogen evolving into higher elements is an anti-entropy process that shouldn't be common because the second law requires energy to create order, but it is. It occurs constantly in all the stars we see and led to the evolution of higher elements. Hydrogen and Oxygen atoms then combined into stable water molecules leading eventually to the self-replicating proteins that allowed primitive cells to evolve. *The evolution of matter opposes the second law of thermodynamics by constantly increasing order in a way that doesn't require any further energy*.

Evolution didn't stop there, as over time, primitive archaea and bacteria cells combined into the modern cells (Lane, 2015) that led to plants, animals and us. The evolution of life was a new combination that did need an energy input to survive but because it reproduces, it is also a permanent increase in order. In general, *evolution acts to increase local order in a permanent way at the same time that the second law of thermodynamics is decreasing order generally*. These two processes are not in opposition because they both derive from the quantum law of all action.

The social version of the second law is *Murphy's law*, that if anything can go wrong, it will, but its opposite is *Adam's law*, that from bad, good can come. Physics has no counter to the second law so it predicts inevitable disorder but *evolution is the universal anti-entropy principle it ignores*.

If evolution was limited to biology, the second law might supremely decide the universe but if matter evolved as life did, evolution is as universal as the second law. The second law predicts a universe devolving into disorder but evolution predicts it is also evolving order. An unstoppable quantum reality is constantly shaking the universe to *possibly* evolve even as it *probably* decays.

Evolution was built into our universe from its inception. The grand evolution of matter and life going on all around us defines the universe as much as physics based on heat flows. The dismal fact that the universe is dying doesn't deny that it is also evolving, and we are the proof. *Evolution explains what the second law cannot, that we are here because ordered life evolved.*

5.6.6. How will the universe end?

In physics, whether the universe will expand forever or contract back into a big crunch depends on how space is curved overall. Relativity lets space curve but doesn't define how it curves. In mathematics, a positively curved space will eventually stop expanding and contract in a big crunch but a negatively curve space will expand faster and faster forever, as there isn't enough mass to stop it. A positive or flat curve was expected until cosmology found that the expansion of space is accelerating not slowing down (Cowen, 2013), so *space is negatively curved*.

Quantum realism expects our space as the inner surface of an expanding hyper-bubble to have the slight negative curve that cosmology found, but doesn't conclude that it will expand forever. If our universe is an expanding bubble in a quantum bulk, there are probably others so they will eventually meet. What happens when one "pocket universe" as Guth calls them meets another?

The answer depends on whether they are matter or anti-matter. If our universe meets another matter universe, they will just merge into a bigger bubble. If this has already happened, our universe will be bigger than it could be by its own expansion, but there is also the *Armageddon option*, that it meets an anti-matter universe.

Gravity is all powerful in our universe because it only *adds* so nothing opposes it. One can block an electric field with an opposite field but nothing opposes gravity. It reigns supreme because our universe took the matter path but matter has an anti-matter opposite that could not only shield gravity but would also *fall up* on earth[4]. If our matter universe meets an anti-matter universe, both will annihilate back into the quantum bulk, to return from whence they came.

If Armageddon has already begun, we won't know right away because it will happen at light speed. Cosmology estimates that our galaxy is over 100,000 light years across and the observable universe is 90 billion light years across so it could take a while to shut-down. Will our telescopes see it coming? There would be no signs, as we see galaxies as they were millions of years ago. *When our physical universe is packed away, it will be at the speed of light with no possible warning*.

5.7. WHY DOES THE UNIVERSE EXIST?

Since time immemorial, people have wondered *why does the universe exist?* The answer varies depending on what you think the universe **is**. If you think the universe is objectively real, then either it was made so for a purpose, or it is just here because it is. But if it has a purpose, why is it mainly empty space? Or if it just is, how did it come into existence from nothing as the big bang implies?

In contrast, virtualism suggests that the physical universe doesn't exist by itself at all but is a virtual reality run by some "other" outside itself. The most well-known version of this view today is the *simulation hypothesis* popularized by the Matrix movie.

5.7.1. The simulation hypothesis

A *simulation* represents something else, so a model of the Empire State building simulates it. An *information simulation* is a virtual reality that represents events in time, like a simulation of the weather. Such simulations can *answer a question*, like what will the weather be like tomorrow? They can also help to *learn skills*, as pilots use flight simulators to learn about a new plane before actually flying it. A third use is to give *observer experiences*, as computer games like SimCity let people experience the challenge of building a city. In every case, the benefit of the simulation lies not in itself but for its creator.

The simulation hypothesis is that our physical reality is a representation so realistic that its participants are unaware that they are living in a simulation. In the film The Matrix, Morpheus says:

> "*What is real? How do you define 'real'? If you're talking about what you can feel, what you can smell, what you can taste and see, then 'real' is simply electrical signals interpreted by your brain*."

In this film, machines in future earth simulate New York in 1999 to humans in vats, by feeding appropriate electrical impulses to their brains. They don't know that the virtual world they live in

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

is fake or that real-world machines are using them as batteries. The key assumption of this science fiction story is that computers in the real physical world can simulate a false virtual reality.

Since it might take a physical computer bigger than our universe to simulate even a part of it, the simulation hypothesis expects processing costs to be critical. It follows that there is no need to actually simulate the details of an uninhabited far-off galaxy if it is only ever seen as a dot of light. It takes less processing to fake it and this logic applies to everything we can't directly verify, like the past and the quantum world. The simulation hypothesis implies a virtual world with a:

a. *Fake history.* Why simulate the 14 billion years before we arrived to see it?

b. *Fake cosmos.* Why simulate galaxies and stars that we can never travel to?

c. *Fake quantum theory.* Why simulate quantum events that we can't observe?

The godlike designers of the simulation only have to make it *appear* real, as movies do, so there should be anomalies that prove it is just a simulation. Assuming the reality we see is a fake, simulation supporters base their case on *finding flaws in the simulation.*

For example, quantum theory uses physically impossible quantum events predict to physical effects so simulation theory expects to find flaws in its predictions (Campbell, Owhadi, Sauvageau, & Watkinson, 2017), but as critics have been trying to disprove quantum theory for over a hundred years, this is unlikely to succeed. Even if it did, finding a quantum theory fault would just result in it being revised because theories don't succeed in science by falsifying others. Simulation theory has to predict positive results that quantum theory doesn't, which it doesn't do.

The key simulation hypothesis premise is that what generates physical events is also physical but quantum Hall research shows that classical processing complexity increases exponentially with the number of particles. It turns out that to simulate just a few hundred electrons requires more physical atoms than the universe has, let alone simulating New York city. If a universe that behaves as quantum theory says can't be physically computed, we aren't living in a computer simulation.

If the simulation hypothesis *that our reality is a computer-generated simulation is impossible,* that machines, aliens, or our future-selves are simulating our reality from another physical world isn't possible either. The "other" of virtualism can't have a physical base, either as *programs* that need physical hardware, *information* that needs the same or *dreams* that need a physical brain, *but it could be quantum based*.

Quantum processing increases exponentially with the number of processors, so it can scale to handle a physical reality whose demands also scale with size. If the physical world is a simulation, it must simulate something but in quantum realism, there is no physical world and there never was. It is a virtual reality never seen before not a simulation of what already exists. What creates a virtual reality doesn't need it to exist, so quantum reality doesn't need a physical base to do what it does.

In quantum realism, processing cost isn't an issue because quantum reality is always active, so the physical world isn't fake as simulation theory says. The virtual reality generated by quantum reality has no holes, so every second of the past fourteen billion years happened, every far-away galaxy we see in our telescopes exists and everything quantum theory describes is literally true.

Our universe is a virtual reality on a scale we can barely imagine, for a reason we have almost no awareness of, any more than the billions of animals that lived and died in biological history had any idea that they were part of an evolution. If the universe was born to evolve, everything it has produced since its birth, from matter to life, has been by some form of evolution. Evolution is what our universe is all about, but what is it?

5.7.2. What is evolution?

Ever since science parted from religion on the origin of man, biology has denied that evolution has a *direction*. It currently sees evolution as a *purposeless process* going nowhere, so if time was reversed to let evolution run again, it would give entirely different results because the same random events would be unlikely to repeat (Gould, 1990). But others note that given the same conditions, evolution repeatedly finds the same solutions despite random events, so replaying the evolutionary tape might give much the same results (Morris, 2003). For example, birds, bats, insects and fish all evolved wings to fly, despite following unrelated evolutionary paths, because it benefits survival.

The argument is that replaying evolution would still give cells with membranes, reproduction, predators and prey, parasites and hosts because that system works. A way to capture solar energy like photosynthesis would still arise, giving plants as primary producers and animals as secondary consumers, with sight, smell, hearing and mobility based on fins, limbs or wings. The argument isn't that playing the tape again would give humans but that something like us is likely to reappear.

Evolutionary algorithms are programs that work the way evolution does. They create a set of solutions, randomly tweak those that work, then repeat until a best solution emerges. This method can solve difficult problems that direct calculation can't because it tends to the same answer if only one way works. If a best answer exists, rerunning the algorithm repeatedly finds it, so while it uses trial-and-error, it has a *direction* that it always arrives at.

If evolution is an algorithm exploring what life forms work, rerunning it might give the same results if they are the answers that work. In evolutionary potential studies, researchers replaying the tape of life on a small scale with generations of bacteria find that Gould's idea that evolution never repeats is incorrect. Natural selection isn't a chess player that plans several moves ahead but it isn't just happenstance either, because exploring all the options eventually leads to a solution. Hence, we run evolutionary algorithms to get answers not random outcomes

It pays to try every option, good or bad, because some changes lead to later benefits. Evolution is the exploration of quantum combinations that survive, like electrons, quarks, atoms, molecules, cells and organisms. Each gives a local order increase if it can preserve itself. To ask if evolution converges to common results or diverges to new results is to ignore that it does both. Mostly it converges but sometimes it diverges to create a new branch of the evolutionary tree.

The scale of evolution is hard to comprehend, so it is indeed egotistical, as Gould says, to think that our vast universe has run for billions of years for our sake. The universe isn't just for us, as it existed long before we came and will no doubt continue long after we are gone.

Life involves permutations and combinations so vast that we can't conclude that a hairless ape had to result. Homo-sapiens was the lucky ape that won the evolution lottery but after four billion years, some species had to because beings like us are *possible*. The unfortunate corollary is that if we prove unstable, something else may take our place, as the grand evolution is far from over.

If evolution in general increases order by finding combinations that are stable, then the tree of life is growing in a direction that can be measured by the *evolutionary steps that increase order.* For example, the merging of simple cells into a complex cell that led to plants and animals (Lane, 2015) was an order-increasing evolutionary step as merging atoms into molecules was. Biologists currently say that bacteria are just as "evolved" as we are, or more so as they have been around longer, but time elapsed doesn't actually measure evolution. In terms of order, a human is more evolved than a simple cell because there are more order increasing steps in the ancestry of humans.

The earth took about a billion years to discover the self-replicating molecules that led to life, and it was another three billion plus years before sentient beings like us emerged. Given the effort involved, who are we to call it pointless? The first atom was an accident, as was the first molecule, the first cell, the first plant and the first animal, but the trend to increase order is no accident because it happened again and again. That evolution uses accident doesn't make evolution itself an accident.

In biology, the argument that the universe is purposeless takes the form that the genes causing us have no purpose so neither do we:

> "*The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil and no good, nothing but blind pitiless indifference. … DNA neither knows nor cares. DNA just is. And we dance to its music.*" (Dawkins, 1995) p133.

It is evident that physical causes like genes have no purpose but to conclude that life in general has no purpose requires the additional assumption that the physical world is all there is. It doesn't matter that the physical world is a machine with no purpose if it something else created it, as the conclusion that our universe began suggests. The argument that biology implies purposelessness is thus essentially based on a physical realism that isn't obviously true at all. If the universe was created to evolve, whether it has no purpose is an open question not a foregone conclusion.

Our universe is constantly trying every possibility, as if it was looking for something, like an algorithm set up to solve a problem. Maybe evolution doesn't have a design because *it is the design*. If biological evolution is part of a universal evolution that created the matter, stars and galaxies that planets like earth needed to evolve life, why was it set up to do this? That the physical world is a virtual reality suggests the answer has something to do with what observes it.

5.7.3. Why do virtual realities exist?

A world of inert matter just exists but virtual realities need power to run. If the power fails during a computer game, even for a second, we lose the current state and must restart from our last save. If our world is a virtual reality generated by quantum processing that can't be saved, it is like an iron man game that has no saves, so the only restart is from the beginning, which for our universe was 14 billion years ago! An unbroken causal chain links the universe now to the first event so it must have run all that time without losing a single quantum cycle. The quantum power needed to support a virtual universe as big as ours for that length of time is vast.

One can create a thing and walk away but a virtual reality must be constantly sustained, so whatever made our universe had to also sustain it for every moment that followed. It beggar's belief that the power needed to run a virtual reality that big for so long was pointless. If the universe is a joke, it is a ridiculously expensive one, even in quantum terms. Virtual realities don't run for no reason because it takes power to sustain them, so if our world is a virtual reality, why is it running?

Virtual realities don't exist for themselves. The purpose of the game civilization isn't to create a civilization to conquer a virtual world, as if it was, it would work better without players. Likewise, SimCity doesn't exist to build a virtual city, Minecraft doesn't exist to dig virtual tunnels and the Witcher game doesn't exist to slay virtual monsters. None of these virtual realities exist for any purpose within themselves but rather exist to benefit their observers in various ways.

A physical universe may have no purpose in itself but if it is virtual, it must benefit its observer. Every virtual reality has an observer benefit, as a virtual reality has no point if it isn't observed. If the physical world runs not for itself but for its *observer,* then its evolution must also benefit the observer. This raises the question of *what observes our virtual reality?*

Science agrees that we are in an *observer-observed universe,* what physics calls a participatory universe, but there is no agreement at all about *who or what is the observer?* This chapter ends the analysis of *physical reality* from a quantum realism perspective to raise the question of what is the *observer reality*? The next chapter applies quantum realism to the *mystery of consciousness*.

DISCUSSION QUESTIONS

The following questions are addressed in this chapter. They are better discussed in a group to allow a variety of opinions to emerge. The relevant section link is given after each question:

1. How can quantum theory and relativity theory both be correct? (5.1.1)

2. Why can't quantum theory explain gravity as relativity theory does? (5.1.2)

3. If the earth is a moving platform, how fast is it carrying us? (5.2.1)

4. Why did Einstein say that special relativity is why our reality *isn't* weird? (5.2.2)

5. Why does causality require the speed of light to be constant? (5.2.3)

6. Could I travel to a star that is 100 light years away and back in my lifetime? What is the downside of doing this? (5.2.4)

7. How can the same photon pass rockets going towards and away from it at the same speed? (5.2.5)

8. What is zitterbewegung? What theory makes it possible? (5.3.1)

9. How can a photon move at all if time stops for it, as special relativity says? (5.3.2)

10. How do solar sails convert radiant energy into kinetic energy of movement? (5.3.3)

11. How can the earth's gravity change the time and space of objects around it? (5.4.2)

12. How can the earth accelerate a free-falling parachutist with no direct contact? (5.4.3)

13. How does gravity bend light that has no mass? (5.4.4)

14. What quantum field changes cause opposite charges to attract? (5.5.2)

15. What quantum field changes cause opposite magnetic poles to attract? (5.5.3)

16. What three matter properties spread to give gravitational, electric and magnetic fields? (5.5.4)

17. According to current physics, where is potential energy stored? (5.6.1)

18. Is energy universally conserved? What is universally conserved? (5.6.2)

19. How did the evolution of matter increase entropy? (5.6.5)

20. According to quantum realism, how will our universe end? (5.6.6)

21. Could our world be a simulation generated by another physical world? Why or why not? (5.7.1)

22. How does quantum realism differ from the simulation hypothesis? (5.7.1)

23. Does that evolution is a physical process with random events mean life has no purpose? (5.7.2)

24. Why is the observer relevant to the purpose of virtual reality? (5.7.3)

REFERENCES

Barcelo, C., Liberati, S., Sonego, S., & Visser, M. (2009). Black stars not holes. *Scientific American*, *301*(4), 20–27.

Barrow, J. D. (2007). *New theories of everything*. Oxford University Press.

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

Dawkins, R. (1995). *River Out Of Eden*. New York.

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

Galfard, C. (2016). *The Universe in Your Hand: A Journey Through Space, Time, and Beyond* (First Edition edition). Flatiron Books.

Gould, S. J. (1990). *Wonderful Life: The Burgess Shale and the Nature of History*. W. W. Norton & Company.

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

Harrison, E. R. (1986). *Masks of the Universe*. Cambridge University Press.

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

Morris, S. (2003). *Life's Solution: Inevitable Humans in a Lonely Universe*. Cambridge University Press.

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

Strogatz, S. H. (Steven H. (2003). *Sync: The emerging science of spontaneous order*. New York : Hyperion. http://archive.org/details/syncemergingscie00stro

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