Chapter 10. Spin Like a Dervish, Drop Like a Stone

We will continue our exploration of the particle zoo with attention on the photons, and while we are at it, we will take a closer look at the mysterious neutrinos and their relation to photons. In our presentation of the photon we will skip most of the details of optics which are covered very adequately in available textbooks. We will just focus on certain aspects that are fundamental to the behavior of photons and their relations to the basic fermion particles and that help to introduce our paradigm of the role of the observer in physics.

In our previous discussion we began to consider the way in which photons go through a phase transition from boson behavior to fermion behavior, and found that it involves what appears to be translational behavior and rotational behavior. The basic concept is that as a photon wave carries more energy, its frequency increases, and that also corresponds to a decrease in wavelength. As the wavelength gets shorter, the opportunities for the photon to slip into predominantly rotational mode become increasingly greater. Beyond a certain threshold wavelength the distinction between going somewhere as a wave and relatively staying put as a particle becomes indistinct. The wave overwrites itself. At very high energies the photon's probability of mode is almost entirely rotational. Also, under the right conditions, this transition to rotational mode can be precipitated, much like a catalyst can precipitate chemicals, so there is a gray area in the energy world where photons can form quasi-fermions -- what we call neutrinos. Of course, an eddy can still move in translational mode while it rotates.

The first window for photons to transition into rotational mode occurs at the rest mass of the electron neutrino. We discovered that this neutrino "rest" mass is formed by the interaction of the smallest and largest scales of the universe, ($\hbar$) and (c) within a certain spatial displacement. In our last chapter we calculated an idealized neutrino and a revised form of the Planck mass by discovering we needed to include the fine-structure constant in order to unify quantum gravity and electricity.

* $m_{ne} = \hbar / c \, \% = 1.11 \times 10^{-43}$ kg.
* $B_u^2 = (\hbar \, c \, a / G)$.

We recall that ($\hbar \, c$) is just a fractal echo of (%). Of course, this is also just another way of looking at our original definition of B_u^2. When we substitute for (a) we get the quantum electricity version clearly expressed:

* $B_u^2 = e^2 \, \text{Ao} / \text{As} \, \pi \, \varepsilon_o \, G$.

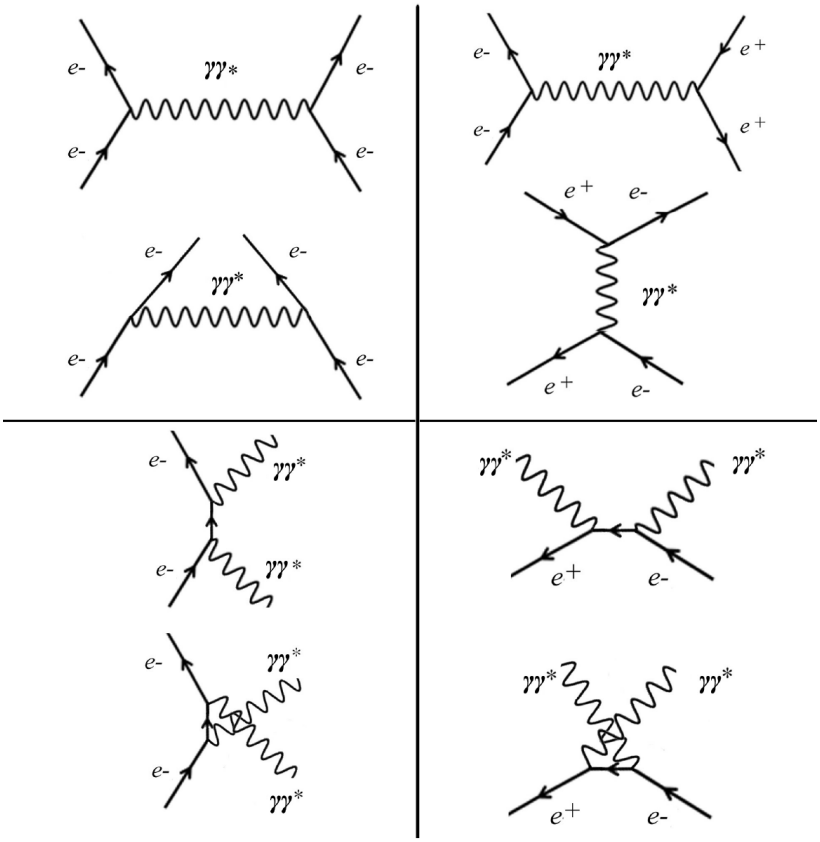
The Planck mass is also another form of the Heisenberg Relation:

* $(B_{u1})(B_{u2} \, G / c \, a) \geq \hbar$.

This means that there is an indeterminacy about the values of (B_{u1}) and (B_{u2}) that can range all over the place under the governance of Planck's constant. But the average

value will be $(B_{u1}) = (B_{u2})$, the requirement that balances the electrostatic and gravitational forces.

The fine-structure constant (fsc) = (a) expresses the relation between the Rydberg energy and the relativistic electron. Here (R_∞) is the Rydberg energy, assuming infinite mass. The fsc thus represents the coupling strength between electrons and photons in terms of ($\hbar$) and (c). The eight possible coupling processes can be represented graphically by Feynman diagrams, and each has a probability proportional to the fsc. Each interaction node in the examples given below looks like a Y with two electron branches and a photon branch, all converging at a vertex. The Y-shape is misleading because the photon component actually involves a photon-antiphoton pair, and the **particle count** (i.e., particles in equals particles out at any interaction node, as well as the energy and charge) is always conserved in any scattering process. Because the photon is a vehicle for the exchange of energy, the properly drawn Feynman diagrams must always show (or at least assume) a pair of electrons connected via a photon exchange so that the photon pair has electron terminals at each end of its path. This preserves conservation of both particles and energy, something that is not always followed when some people draw Feynman diagrams. The fine structure constant is also involved. Therefore the exchange of a single photon is of order a^2; a two-photon exchange is of the order a^4, and so on. Because the value of a is a small probability to begin with, and at each added vertex pair the value of a goes to the power of "two times the order of the vertex number", the probability for more complex diagrams drops off quickly. Below are the 8 basic Feynman diagrams drawn in schematic form.



In this schematic chart I use the Greek letter gamma to represent a generic photon, not necessarily indicating a gamma level of energy. The starred gamma means it is the antiphoton partner of a pair. Time moves upward vertically, and the horizontal axis represents motion in space. Thus electrons (e^-) move upward, and positrons (e^+) move downward -- that is, backward in time. The diagrams on the right hand side show various forms of pair production and annihilation. We can interpret interactions that contain positrons as high energy exchanges that cause an electron to reverse its direction in time as well as space. In that case the photon exchange is two gamma photons, each with a minimum energy of $m_e\ c^2$. In the bottom four diagrams you must fill in an electron or other suitable terminal charged particle to absorb the radiated photons. Wherever the electron charge does not change, the energy level is lower. The spin of the electron is ½, and the spin of the photon (pair) is 1. You can see from the diagrams as I draw them that the photon is really made of two halves, each with spin ½. Because the photon-antiphoton pair runs as a unit, the appearance is spin 1. Electrons approximate spin 1 by forming Cooper pairs, one member with spin up, and one member with spin down. Photon pairs would seem to be the same, but as bosons they like to hug together while the electrons like to scatter.

Exercise: Find a partner and sit facing each other. Look your partner in the eyes while she looks you in the eyes. You send attention particles (antiphotons) from your eyes to your partner and receive reflected photon particles from her face. She sends antiphoton attention particles to you and receives reflected photon particles from your face. Photon particles move forward in time, and attention particles move backward in time. With no attention there is no perception. There is a tiny time lag between your perception of photon particles from your partner and your reception of attention particles from your partner. When you are next to each other, the lag is so small that it is neglible. However, light on average takes over 13 minutes to reach us from Mars, so if you see a big flash on Mars at 1:13, it has taken 13 minutes to reach you, which means your attention particles reached Mars at 1:00 o'clock in order to see the flash. A person on Mars might feel your attention at 1:00 or just before then, but would only see your reaction to the flash at around 1:26. Because attention particles move faster than light and backwards in time, it is possible to have intuitive (or of course prearranged) contact pretty much instantaneously, thus overcoming time lags. For example, when the person on Mars makes the flash happen, he could be aware that someone on Earth will see it 13 minutes later, but the Earth person will also necessarily have attention on Mars at 1:00 in order to see the flash at 1:13.

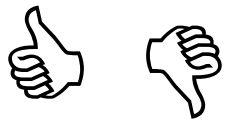
Exercise: Stand and slowly rotate in a clockwise direction. As your attention particles scan in a clockwise motion, you will see incoming photons from your surroundings arrive with a counterclockwise sweep. From this analogy you can get some intuitive idea how half the boson spin is in the photon and half is in the antiphoton (attention particle), and the two halves are in opposite directions.

Despite the incomprehensible manner in which quantum spin is presented in textbooks, it is all quite simple. The mysterious quality of quantum spin depends on two fundamental properties. The first property is common to all spinning objects. Spin is

relative to the observer viewpoint and relative orientation among particles.

Experiment: Find a coffee table with a clear glass surface. (Alternatively use a clear glass pie dish or flat plate of clear plastic.) Find a child's top (or a gyroscope). With your right hand spin the top clockwise on the table top or other clear surface. Stoop down and look up at the top from under the glass. Which way is the top spinning from that viewpoint?

Principle: All spinning objects spin 50% clockwise and 50% anti-clockwise. They are always 1/2 spin up and 1/2 spin down, depending on how the observer looks at them. Quantum particles are no different from ordinary spinning objects in this respect, although they are very different in other respects.

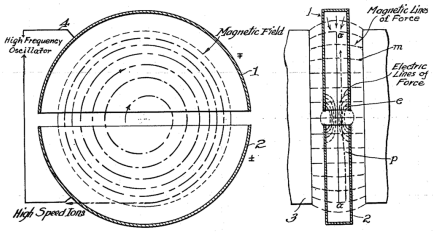


The spin of an electron is like tracing a line around a Möbius band. (Make one and try it.) It takes 720 degrees of "rotation" to complete a single cycle. In the last chapter we showed how the palm of your hand rotates 720 degrees for a complete rotation. Notice the pole shift that takes place during the rotation. The secondary axis rotation means that a single rotation of 360 degrees is only one half of a complete fermion rotation. The boson rotation of photons is more like a pulsation in which the photon and antiphoton mutually coalesce (annihilate), but then re-emerge as a photon and an antiphoton, because each is its own antiparticle. Thus one "360-degree cycle" is indeed one complete cycle for a photon (because its antiphoton partner is simultaneously spinning the other 360-degree cycle in the other direction), whereas the fermion has only gone through half of its cycle. A photon and another photon do not mutually annihilate; they form a neutrino that behaves more like a fermion.

The other mysterious property is that, unlike ordinary spinning objects that can change speed, slow down and even stop spinning, quantum particles can never stop spinning or even change their spin speeds. As we unfold the amazing inner structure of electrons and other quantum particles, we discover that they are all made from various kinds of photon whirlpools. Photons travel at the speed of light, which is constant, although it can seem to change under various conditions of energy density. What seems to be quantum spin is actually the cycling of photons that must always stay at a constant speed in free space, but can appear to slow down in dense energy environments. This becomes clearer when we observe the resonance frequency (f) of a cyclotron. Here is the cyclotron formula:

* $f = q\,B\,/\,2\,\pi\,m,$

where m is the non-relativistic mass of a charged particle moving in the cyclotron, q is its charge, and B is a static magnetic field applied perpendicular to the electrode plane.



(See **Wikipedia**, "Cyclotron")

In the cyclotron model we use a charged particle such as an electron as a substitute for a photon. This is reasonable as we shall see when we examine photon behavior in an electron. However, we must point out that this model is just an **analogy** to show that similar phenomena exist in nature. An electron is popped into the center of the cyclotron magnetic field as shown in the drawing above. Its path will be circular, but with some tangential momentum it begins to spiral outward. In a non-relativistic approximation the particle mass stays close to constant, so the frequency is steady, not depending on the radius of the particle's cyclical path. Therefore, as the particle spirals outward, it accelerates faster and faster to maintain its constant frequency. For an electron we get:

* $r = m_e\, v \,/\, e\, B$ (With all else constant, radius r varies directly with velocity v.)
* $e\, B \,/\, m_e = v \,/\, r$.
* $fc = eB \,/\, 2\pi m_e = B\,(e \,/\, 2\,\pi m_e)$. ($B$ = the magnetic field strength in teslas.)
* $\omega c = eB \,/\, m_e = B\,(e \,/\, Me)$. (Angular frequency $\omega c = 2\,\pi fc$.)
* $\mathbf{(e \,/\, 2\,\pi m_e) = s_e^{-1} = 2.7992{\times}10^{11}\ s^{-1}}$. (electron cyclotron frequency)

The Tesla in SI units is a newton second per coulomb meter, which turns out (in Mech a) to be a dimensionless scaling constant that we can set at some constant value. So the **fundamental electron cyclotron frequency** (disregarding the 2π) is the exact reciprocal of our electron second ($m_e \,/\, e = s_e = 5.6856298544 \times 10^{-12}$ s). It is the same for all electrons and positrons. The value of the frequency depends only on how we set up the B-field. Here we have a clear physical demonstration of the reality of the "electron second" as an important universal constant connecting the charge to the mass of the electron as a frequency or period, depending on how you look at it. The frequency e / $2m_e$ might be a good candidate for a standard frequency, since it is the gyromagnetic ratio of the electron. Additional interesting information is provided about the gyromagnetic ratio at (**Wikipedia**, "Gyromagnetic Ratio").

The gyromagnetic ratio of the proton is a frequency that equals the ratio of the nuclear magneton to the reduced Planck constant. However, it also is the ratio of the speed of light to the circumference of a circle with a radius a few millimeters short of 2 meters. The meter could be defined as the ratio between the light-speed momentum of the proton and π times the quantum unit of charge, or the inverse of the proton gyromagnetic ratio times light speed divided by 2 π.

* $e \,/\, 2m_p = \mu_N \,/\, \hbar$
* $\mu_N = \hbar\, e \,/\, 2m_p$ (The nuclear magneton)

* $m_p = \pi\, e\, b / c.$

* $e / m_p = c / \pi\, b.$

* $\boldsymbol{e / 2m_p = c / 2\, \pi\, b.}$ **(where $b \approx 1$ m)**

* $\boldsymbol{b = m_p\, c / \pi\, e}$
* $\boldsymbol{b = (2m_p / e)\, (c / 2\pi)}$

Perhaps we can find a standard for the second in the gyromagnetic ratio of the electron and a standard for the meter in the gyromagnetic ratio of the proton. Thus time and space have universal metrics in the two components of hydrogen, the most common element in the universe. It should not be too difficult to devise simple and rugged instruments that can give us the meter and the second with great precision under almost any circumstances.

In any case the non-relativistic cyclotron is like a magnified model of a single electron. Photons have no rest mass, so they do not have relativistic considerations, but just appear to move at *c*. Also, they do not have charge, so the mechanism is not directly one of **charge**, but more likely based on **gravity** and **energy density**. The photons spiral outward from the energy dense singularity center point at the core of the electron. As they spiral outward they accelerate. When they reach speed *c*, they radiate as free photons at speed *c* through free space carrying their characteristic cyclical vibration momentum until they are absorbed with the energy that they carry by another charged particle. The electron thus behaves like a tiny white hole. Its "charge" has to do with the dynamic of space-time, and we will explore that as we go along in our model.

Think of the vortex that forms around the drain on a sink as the water drains out. Water spirals in toward the center and then disappears down the drain. Now reverse the process and run it backwards in time. You have water welling up from the drain hole. As it emerges it starts to swirl outward under the pressure of water welling up behind it. Eventually it reaches the edge of the vortex and drifts off into the general water in the sink. The drain functions due to gravity and momentum. Electromagnetic forces are secondary.

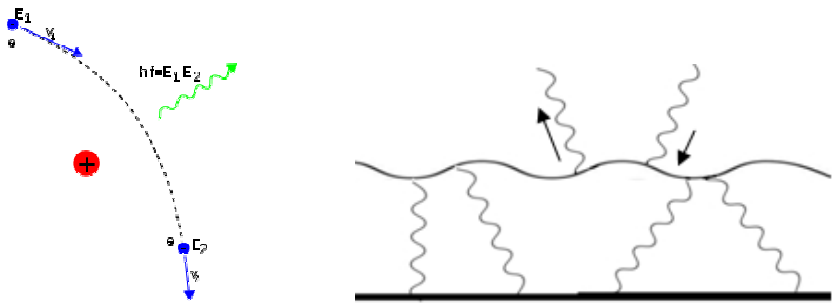
When the photon emerges at the center of the electron, the energy is very dense, so it appears to move slowly. As it spirals outward, the energy density drops off, and the photon appears to accelerate. When the density reaches that approximating free space, the photon radiates away from the electron at its usual free space velocity of *c*. Its preferred destination is a positron (its primordial partner). The positron acts as a black hole and sucks in ambient photons. They spiral inward down its "drain" and disappear at its point center. As the photons enter the positron event horizon, they start moving backward in time and slow down. Eventually they reach a time-space point in hyperspace that corresponds to an original electron-positron pair creation event. The photon then crosses over into the electron singularity and begins its spiral forward in time. The whole process is a continuous circuit of energy flow, since the photons carry the energy. Thus at the point center of the electron-positron, the energy density is greatest,

and in the "free space" gap between the separated particle pair it is least dense. However, the total energy per space remains in a dynamic equilibrium between the point singularity and the illusory free space that we "experience".

Almost all stable positrons are inside protons, buffered by chargeless quarks. Otherwise, they soon encounter free electrons and "decay" back into photons. All electrons and positrons are connected as a single phenomenon in hyperspace, the crossover point of pair creation. Electrons and positrons are mutually reversed in time and separated in space. Positrons are black holes that gobble photons and white holes that spit out antiphotons (i.e., attention particles). Electrons can temporarily "absorb" photons, but this translates into kinetic energy, which is why valence electrons that "absorb" photons become excited and shift to higher energy levels or even leave their orbitals to become "free electrons". Eventually energized electrons lose their extra energy and drop back down toward their "ground state" rest mass, which is simply the basic minimum quantum of energy they received at pair production. The rest energy is only released when an electron-positron pair "annihilates" back into a pair of energetic photons ($2\ m_e\ c^2$). From a different viewpoint particle pair creation and annihilation is really just particles bouncing energetically around in space and time in a matrix of dynamic light energy with no actual creation or annihilation going on.

The ultimate condition is that in the cosmos there is only one fundamental electron-positron pair, since all are connected by an eternal background of hyperspace, "space" being the corresponding expression of energy in its kinetic form that appears during pair creation. Time is simultaneously created with space from the photon energy at electron-positron pair creation and runs both forward and backward in equal measure as it emerges from hyperspace. "Hyperspace" is the source space of photonic light in its potential form. Once we fully understand and master the technology of hyperspace and its expressions as space-time, we will have total access to any point in space or time and gain the ability to shift at will back and forth from pure potential light energy to dynamic physical kinetic systems. The hydrogen atom is a simple structure involving a proton, an electron, and an invisible antineutrino. The neutron is the ensemble fully packed together. Careful study of these basic particle relations will reveal most of the remaining secrets of the universe.

The preferred electromagnetic exchange is between charge and opposite charge (e.g., between electron and positron). Electrons that pass near a charged particle or through a magnetic field take a curved path, losing some energy that is radiated as bremsstrahlung (i.e., photons). Electrons in orbit around a nucleus constantly radiate photons as bremsstrahlung directly to the time-reversed positrons inside the protons of a nucleus.

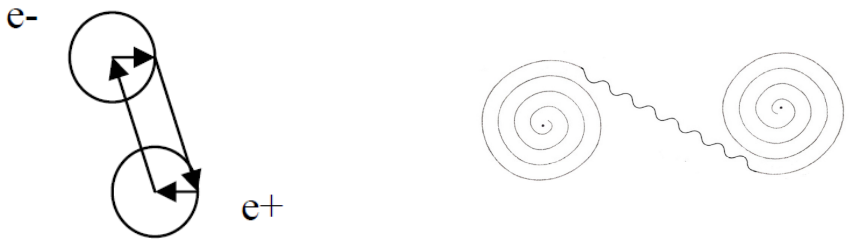


In the above diagram (**Wikipedia**, “Bremsstrahlung”) shows an electron curving past a proton or other particle with positive charge. The electron swerves losing energy. It changes velocity, and gives off a photon (green wavy arrow) equal to the lost energy. The drawing on the right is based on a sketch by Feynman. The dark solid line represents the boundary of a proton (stretched out) and the long relatively "gently" undulating line is the path of the electron in orbit around the proton. The bremsstrahlung photons exchange energy (the tight wavy lines) between the electron and a positron inside the proton as the electron swerves around its orbit. At the top of the sketch a photon from outside the atom is temporarily absorbed by the electron and then emitted back out. The sketch does not show the adjustment of the electron orbit swerving outward due to the additional energy absorbed from the externally arriving photon. The emission of photons to the proton forms bremsstrahlung (braking radiation) as the electron swerves inward under the influence of the charge. Inner bremsstrahlung is not observable, but outer bremsstrahlung is observable when an electron swerves in a cyclotron or other EM field. (See similar diagrams and an explanation of the unseen exchanges on p. 100 of Feynman's **QED**, -- although Feynman there does not say that the photons go to positrons inside the proton, but just to the proton, which is roughly OK. The sketch on the left should also show an unseen photon passing between the electron and the proton.)

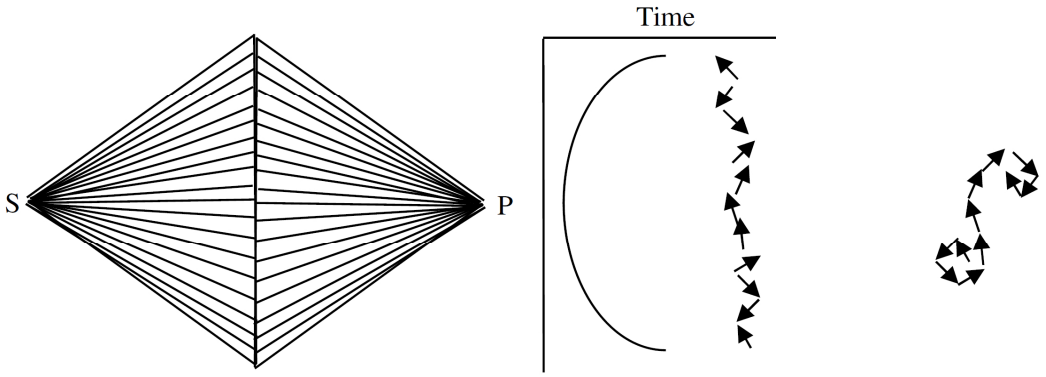
Experiment: Find a sink with a faucet that is offset from the drain, or hook a short hose to the faucet so as to offset the faucet’s inflow. Plug the drain and fill the sink about half full of water. Then pull the plug and allow the sink to start draining. Keep the spigot on so that the inflow of water matches the outflow through the drain. You will see a water vortex form over the drain, and there will be an empty space in the middle of the vortex that represents the positron antiparticle. The spigot represents the electron. The flow of water from the spigot represents photon energy. The excess water in the sink represents the quark ensemble that creates a temporary holding tank for energy and a protective space in which the positron vortex may exist without annihilating with an electron. If you shut off the spigot at the faucet, the water drains out of the sink and the "positron" disappears. The energy disperses back into the environment. Protons and electrons are mutually conditioned and co-dependent. The quark structure is to insulate the positron from the electron so that they do not "short out".

The positrons inside the proton reverse the cyclotron unwinding process and suck the photons winding down their black hole drains back into the past where the positron is produced together with its electron buddy during pair creation. The photon then cycles

back out from the electron and so on in an endless circuit, oscillating back and forth in both space and time. This also, by the way, explains why electrons can emit charge endlessly without evaporating away – one of the mysteries of physics that rarely gets attention. Electrons are one terminal of a photon circuit.



These drawings roughly sketch the electron-positron photon circuit. The photon flow is in both space and time and consists of photon-antiphoton pairs that can flow forward or backward in time, since it is all the same for them. The sketch on the left just reduces the circuit to four vectors. Note the similarity of the "cyclotron" sketch on the right to Feynman's QED drawing of the photon probability "path". Below is a rough sketch based on a drawing in Feynman's **QED**, p. 57.



In the above drawings the photons go from S to P. Feynman uses straight lines to simplify, abstractly representing all sorts of squiggly possible paths. The longer paths take more time. The shorter paths take less time. The "time" arrows show how the longer paths all cancel out. Note the similarity of Feynman's arrow spiral to the schematic Archimedean spiral I drew for the photon circuit between electron and positron. The closer the photon is to the electron singularity point, the longer it takes to travel a given distance. It also goes in every direction, ever more tightly winding. Feynman uses tiny clock hands, but little vectors do as well. So Feynman was really on the right track, but did not go far enough into the fine structure. From this we begin to get a glimmer of the role of gravity in quantum structure and how charge works, but we will have to come back again for a deeper look later on when we delve into gravity and cosmology.

Now let's use our insights into the neutrino structure to take another look at the electron and proton and see if we can come up with a single elegant quantum pattern by which the

resonant windows for union pairs build up into quantum particles.

We here give a summary of the structures of the basic particles we have identified so far:

* **$B_u^2 = (\hbar\ c\ a\ /\ G)$.**
* **$m_{ne} = (\hbar\ /\ c\ \%)$.**
* **$m_e = (\hbar\ /\ e)\ (\varepsilon_o\ \%\ a^2)$,** or $(\hbar\ /\ e)\ (\varepsilon_o\ \pi\ b\ a^2)$
* **$m_p = (\pi\ e\ b\ /\ c)$.**

Recall that $b = R = 1$ meter. That's it. It's about as simple as you can get. We also found expressions for the electron that are especially amenable to measurement: the Rydberg version $(2\ R_\infty\ h\ /\ c\ a^2)$, and the Compton version $m_e = \hbar\ /\ c\ \lambda_e$. The electron version given in the list above is refined from the discussions in the past two chapters. These particles are built from three of the simplest ways to get a mass from the physical constants that fall in the range for subatomic particles. The D-Shift constant plays an important role in these relations. Note also how the proton and electron charges cancel out when they interact, and the electron includes the square of the (fsc) as the coupling mechanism for exchanging photons. Most of the observable photon exchanges in our universe go on among electrons and between electrons and protons. Our expression for the electron just shows the "ground state" or lowest order coupling. Higher order (*n*th degree) couplings are of course possible (with a^2n) as well as couplings with other charged particles. The electron is "set up" in its simplest form to be a terminal for photon energy exchange.

When we look at the particles from the $(B_u^2)\ (G\ k)$ viewpoint rather than the "$\hbar$" viewpoint, we notice another pattern.

^^

* **$m_{ne} = B_u^2\ (G\ /\ c^2\ \%\ a)$.**
* **$me = B_u^2\ (G\ \varepsilon_o\ \%\ a\ /\ c\ e)$.**
* **$mp = B_u^2\ (G\ \varepsilon_o\ \pi^2\ \mathrm{As}\ /\ c\ e\ \%)$.**

^^^

Each particle has a quark made of some constant multiple of (*G*) that takes out its space/time units leaving a kg^{-1} unit. If we move the quark over to interact with the fundamental particle, then we get an equation that looks very much like the Velocity Equation for photons. Let's put the above equations into a general format, to see how the B_u particle is similar to a very "heavy" photon that runs in a circle rather than a straight line.

* $(v_g)\ (v_p) = c^2$. (in terms of velocity)
* $(m_x)\ (m_y) = B_u^2$. (in terms of mass)

We realize that these are really the same relationship. But the photon relation is expressed in translational mode, and the particle-mass relationship is expressed by photons in rotational mode, or we should say, at the crossover point between orbiting and rotating,

which is the event horizon of a black hole.

What comes out of this is the concept that, just as the new paradigm for photons is Phase Conjugation or Four-Wave Mixing, we can now begin to explore the other half of the coin -- Mass Conjugation and Four-Particle Mixing. Phase conjugation is a general principle that can be applied to all systems that can be described by waves, and that includes particles, as de Broglie demonstrated.

Quantum mechanics has recognized that there is a wave-particle duality in nature. Whether a given situation involves waves or particles is up to the OBSERVER, who must choose the viewpoint for interpreting the situation. So Mass Conjugation and Four-Particle Mixing are fundamentally equivalent to Phase Conjugation and Four-Wave Mixing. A pure photon wave is a sinusoidal vibration translating through space/time. The possibilities of group waves and, through the de Broglie relation, particles described by waves, arises when we have phase relations. Phase is the aspect of an oscillation that indicates its relation to another oscillation. It never occurs in total isolation. It always requires a reference point. We identified four particles in an ensemble: (m_x), (m_y), (B_{u1}) and (B_{u2}), just like we identified four traveling waves in our Velocity Equation: (v_g), (v_p), (c_1), and (c_2). In our particle scheme (as with the Velocity Equation), it is arbitrary which parts of the equation we take as constant. We can set the fundamental particles and their quarks as constant and vary the values of (B_{u1}) and (B_{u2}), or we can set the B_u's as a constant and vary the masses of the other particles involved. The expression (G / c^2 %) is the fundamental of a set of harmonic relations that generates every possible particle.

In passing we note that the other subatomic particles classed as baryons are unstable resonances of the proton. The only stable resonances are quantum multiples of the proton. Other baryons or mesons do not fall into that window. The neutral lambda-udb comes fairly close to six proton masses, especially if we figure 3 neutrons and 3 protons. That corresponds to lithium, but lithium's atomic weight turns out to be 6.941, shifted for various reasons a good deal beyond 6 protons. If these heavy-"bottomed" lambdas could be produced in quantity, we might be able to finesse them into becoming lithium atoms. But they require lots of energy to make, so it's much easier to work with hydrogen or deuterium. Thus, electron orbits come in increments of the angular momentum condition:

* $L_n = (n\ h / 2\ \pi) = (n\ \hbar)$

So also the proton "nuclear orbit" increments roughly as ($n\ m_p$), with various factors involved such as the build-up of nucleonic charge, and so on. How nucleons can build up despite the like charges of protons is something we will take up later on. Current physics has opted for theories such as Quantum Chromo-Dynamics (QCD), gluon particles, and oxymoronic principles such as "asymptotic freedom".

Phase Conjugation and Four-Wave Mixing

While we are discussing the nature of photons I will introduce more fully Phase

Conjugation and Four-Wave Mixing from the standpoint of waves. The following development of concepts and properties of phase conjugate waves is based on **Phase Conjugate Optics** by Jun-Ichi Sakai (New York: McGraw-Hill, 1992), Chapter 2. The classic work on the subject was by Zel'dovich, Pilipetsky and Shkunov, the Russian scientists who discovered the paradigm in 1972. Zel'dovich wrote **Principles of Phase Conjugation**, and it was published by Springer-Verlag in 1985.

Most people do not realize this, but the discovery of phase conjugation by Zel'dovich *et al*. brought Einstein's original vision of the possibility of stimulated emission to the level of a new paradigm for physics with countless practical applications and brilliant theoretical elegance. Although those who know of it often speak in terms of mixing light waves, the Zel'dovich paradigm is totally general and holds not only for Maxwell's electromagnetic equations but for ANY wave phenomenon (including vibrations of sound, water, consciousness, and so on). And, as we are discovering, it also can be extended to include the world of particles. It can be generated using any material with the proper preparation. And the properties that it manifests are therefore universal properties of ALL wave forms, and that means basically EVERYTHING, including mental activity. Hence it constitutes a paradigm shift on the magnitude of quantum mechanics and relativity, or bigger, although the magnitude of the paradigm has not yet fully entered the popular awareness. We will begin with the following equation.

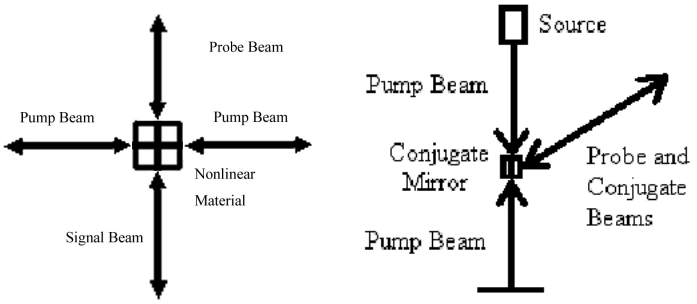
* $W_p\,(R\_, t) = (1/2)\,A_p\,(x, y)\,e^{i(\omega t - KpZ)} + \text{c.c.}$

Here (W_p) is called the "probe" wave, (+Z) is its direction, (ω) is its frequency, $A_p\,(x, y)$ is its amplitude, (K_p) is the wave number in the (Z) direction, ($R\_$) is the position vector, and (c.c.) is the complex conjugate of the first part of the expression. Polarization and spatial data can also be included. The subscript *p*'s indicate the probe wave.
The probe wave has a reflected conjugate wave:

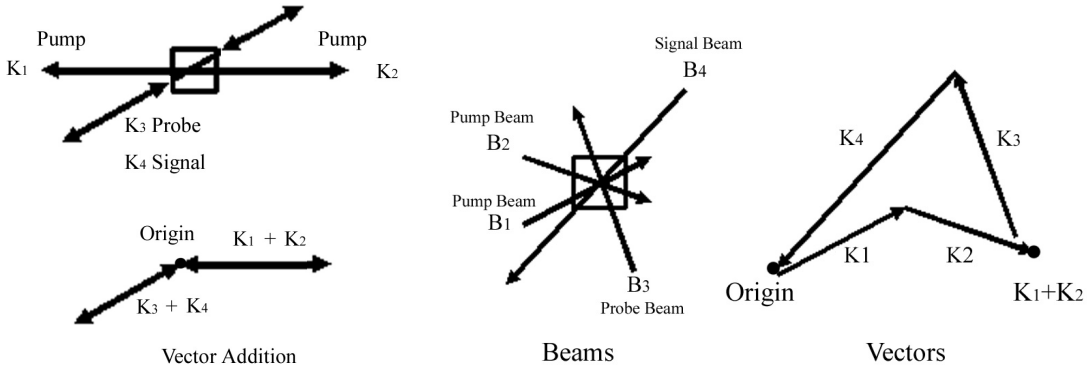
* $W_c\,(R\_, t) = (1/2)\,A_c\,(x, y)\,e^{i(\omega t - Kc\,Z)} + \text{c.c.}$

This wave is the same except that we write subscript ($_c$)'s for the ($_p$)'s to show that this is the conjugate wave. The conjugate wave is also in the (Z) axis. This wave (W_c) is the phase-conjugate wave corresponding to (W_p), so $A_c = A_p$*, and $K_c = -K_p$,

We then have a pair of conjugate waves: [W] and [W]*. [W]* is sometimes called the **star wave**, because it is marked with an asterisk (star) symbol.



In the middle of the above drawings is a nonlinear medium that serves as the mirror. The horizontal beams on the left and vertical beams on the right represent the pump beams. They excite the electrons in the nonlinear medium so that the medium forms an interference pattern with standing waves, and, if the amplitude is high enough, the refractive index changes and forms parallel planes that act like a Bragg diffractor, as if the nonlinear material has become a crystal lattice and acts like a mirror. In the diagram on the left the vertical beams represent the probe beam and its conjugate signal beam. The reflection from a phase conjugate mirror is always backward in the direction of the image, no matter what the angle. The above example is orthogonal. If we change the probe beam angles the signal beam will track the probe beam wherever it is. The rule is that the sum of the vectors of the beams always returns to the starting point. If you put the pump beams at different angles, then the signal completes the trip and the angles of incidence and reflection always match.



In the above example in which all the beams have different angles note that the probe beam B3 bisects the angle between the pump beam B2 and the signal beam B4 or we can say that pump beam B2 bisects the angle between the pump beam B1 and the probe beam B3. The sum of the vectors K1, K2, K3, and K4 returns to the origin.

But how is it that the reflection seems to travel backward in time? Mathematically we can take a very simple case and express the incident signal wave E_i in the electric field that falls in a perpendicular manner along the z-axis on a plane phase conjugate mirror. In the equation z is the displacement on the z-axis, t is elapsed time in seconds, k is the wave number or spatial frequency, and ω is the temporal frequency. E_o is the origin point of the wave at $t = 0$.

§ $E_i = E_o \cos(kz - \omega t)$.

Or we can separate the spatial and temporal components of the wave in complex notation:

§ $E_i = E_o \, e^{i(kz - \omega t)} = E_o \, e^{ikz} \, e^{-i\omega t} = E(z) \, e^{-i\omega t}$.

Here again E_i is an incident plane wave in the electric field, E_o is the starting point as the wave begins to travel through space and time, e is the mathematical constant used as the

base for natural logarithms (not in italics to distinguish it from the elementary charge constant *e*). In phase conjugation there is no phase offset component, so we leave that out. The conjugate reflection E_r will travel back over the path of the signal wave and will have the same shape except for the opposite direction. We reverse the sign for the direction.

§ $E_r = E_o \cos(-kz - \omega t)$.

§ $E_r = E_o \, e^{-ikz} \, e^{-i\omega t} = E^*(z) \, e^{-i\omega t}$.

The complex form using exponents produces the complex conjugate, so we call it a phase conjugated wave and mark it with a star. Some call it the star wave. In the reflected wave the sign of the spatial component of the phase reverses because it is traveling in the opposite direction. This turns out to be the same as the complex conjugate wave. In other words reversing the sign of the time component (i.e. time reversal) is the same as reversing the direction of the wave's motion in space as long as the waves have the same frequency. In other words, using cosine notation:

§ $\cos(kz - \omega(-t)) = \cos(kz + \omega t) = \cos(-kz - \omega t)$.

We lose sight of this phenomenon because light and other waves are usually a mixture of many different frequencies all out of phase so that the effect gets washed out in most ordinary cases unless the wave phenomena are very coherent and in phase. This powerful result is not only true of optical phenomena, but is true of any type of wave phenomenon, and every phenomenon in our universe can be interpreted as a wave or a set of waves – including particles. Although current applications require pumping of a nonlinear medium, the principle is actually general and can be found everywhere once we know how to look for it.

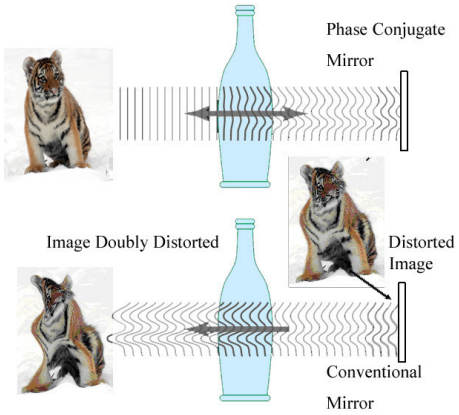
Another fundamental result of this finding is to confirm the notion that disturbances propagate in all directions, including "backwards". The remarkable tracking property of a phase conjugate mirror strikingly demonstrates this. A beam of coherent light such as a laser is by nature strongly excited, monochromatic (of single frequency), **and** bidirectional because of the optical cavity reflection chamber used as a gain medium. Thus it is a handy tool to bring phase conjugation phenomena to the fore.

* $W_c(R\_, t) = W_p(R\_, -t)$.

The shape of the wave is the same, but it is reversed in time. Thus the reflecting material used to make a phase-conjugate reflection is called a phase-conjugate mirror. A conventional mirror reverses a plane wave in space, whereas a conjugate mirror reverses a plane wave in time. Thus it is self-correcting. If part of the plane wave passes through a distorting influence such as a piece of glass, the plane wave is distorted. On the return trip, the glass further distorts the reflected plane wave. A phase-conjugate reflected plane wave reverses the distortion as it passes back through the glass, so that the beam returns to its source self-corrected and undistorted. This looks like magic, but it is

just a shift of perspective from reflecting in space to reflecting in time.

A conventional mirror changes a wave's polarization, but the polarization of a wave reflected in a conjugate mirror is unchanged. Conventional mirrors attenuate reflectance, but phase-conjugate mirrors allow you to amplify the reflection. With a conventional mirror the angle of reflection equals the angle of incidence, but with a phase conjugate mirror the phase inverts and the wave front reflects in the same direction as the probe.



(Image from **Wikipedia**, "Optical Phase Conjugation".)

Through de Broglie's wave equation for particles with mass and the framework of quantum mechanics we can write any particle as a wave equation. Thus all the principles of Phase Conjugation apply equally to particles with mass. Hence we coin the term Mass Conjugation and Four-Particle Mixing.

The secret to making many protons and neutrons is to reflect them back and forth in time as packets of energy using the principle of phase conjugation. The Era of Inflation posited by cosmologists corresponds to this superluminal phase conjugation that turns one particle into an illusion of many. The world that we experience is a projection of attention through the nonlinear medium of the various beliefs that we hold. (Beliefs are nonlinear because they are distortions of awareness. If we compare awareness to Euclidean space, then thoughts are like stars, planets, and black holes that seem to bend space around them gravitationally. Thoughts are like focal points in awareness that attract attention. “Attraction” is a misnomer. As we go deeper into EM and gravitational forces we will discover how the illusion of attraction arises. For now just remember that notions such as distance and separation are illusions – partial understandings – just like the idea that the sun goes around the earth each day.) We can allow attention to echo back and forth in the cavity of the mind until it generates a powerful beam of coherent attention.

Now that we have developed in a little more detail the general theory of Phase Conjugation, let's develop a bit more the idea of Four-Wave Mixing. You can pump a medium from opposite directions with conjugate beams. Then you add a third beam -- the probe beam -- with the same frequency as the pump beams. This produces a fourth

beam in the opposite direction of the probe. Because the frequency is the same, you can use the same source for pumps and probe. You can use many different materials as the medium for your conjugate mirror.

There are so many ways to generate phase conjugation and apply it that we leave that subject for the interested reader to explore. The technology is already well under exploration and development. Our purpose is to draw attention to the paradigm and point out that it carries over into the world of subatomic particles and even to macroscopic objects as well as simple waveforms such as light, sound, and waves of liquid. Phase conjugation contains the holographic principle. It is a simple way of shifting scale in various dimensions.

Perhaps the most important principle derived from phase conjugation can be seen in the laser and in the mathematics of the complex conjugate. In a laser you pump the "mirror" material from opposite sides to excite its valence electrons until you invert the electron population from a state of low excitation to a state of high excitation. The excited population then relaxes in a cascade, releasing photons of the same wavelength and direction to form coherent light. This release of photons forms the probe beam. You allow the probe beam to reflect back and forth in a linear cavity bound by mirrors until a monochromatic radiation that is highly aligned multiplies to form a coherent beam in which every photon's wave form lines up in step. From this you can understand that the beam consists of phase conjugate photons that go in opposite directions but perfectly overlap. The laser is thus an amplified version of a single photon-antiphoton pair that by its nature in free space has perfect phase conjugation and in the resonant cavity forms a standing wave, one partner going "forward" in space-time, and the other going "backward" in space-time, all while translating through the same spatial displacement.

A further exemplification of the conjugate pairing of photons is already inherent in the classical Huygens bubble model (also developed by Fresnel) of the wave propagation of light in free space based on the isotropy of space. From a point source a photon "wave" expands in all directions forming a wave front. The front expands so rapidly at speed c that at any local point in the expanding wave front the front quickly appears to be a flat plane. Huygens proposed that at each point as the wave expands it re-propagates itself as a point source. That means the energy of an expanding photon "wave" front excites space into a quantum foam of bubbles. From this it follows that a "photon" takes every possible path from its point of emission. The odd thing is that the physicists threw out the back-propagating wave fronts, because that seemed to make no sense, even though you can clearly walk around a lamp and see the light it radiates in all directions. Later with Kirchoff's diffraction formula and Feynman's QED the omni-directionality (where unobstructed) was restored.

* $U(r_o) = U_o\, e^{ikr_o} / r_o.$

A disturbance expands from a point source P_o radially r_o in all directions. U_o is the complex amplitude of a spherical wave with wavelength λ and wave number $k = 2\pi/\lambda$. The formula gives the value of the complex amplitude of the primary wave at point Q

with distance r_o from P_o. According to the principle of superposition of waves at a further point *P,* you sum the contributions of each point on the sphere with radius r_o.

In QED "the wave function of any object propagates along all available unobstructed paths. When integrated along all possible paths, with a phase factor proportional to the path length, the interference of the wave-functions correctly predicts observable phenomena. Every point on the wave front acts as the source of secondary wavelets that spread out in the forward direction with the same speed as the wave. The new wave front is found by constructing the surface tangent to the secondary wavelets." (See **Wikipedia**, "Huygens-Fresnel Principle" that has a number of nice animated graphics illustrating wave behavior.) The ultimate "path length" for a photon quantum of light is determined according to where the photon is absorbed. From the description it is clear that the "shortest path" resultant must include the non-intuitive complex conjugate backward propagated resultant, the vital role of which is exemplified in laser technology and holography. This is why the ancients were right when they said that the observer emits attention particles at any object she observes, and the modern physicists are also right when they describe a photon particle emitted from an object and absorbed by the eye. The hologram principle shows how a whole set of data can be encoded in recoverable form at every point in a data field. Feynman's QED and Zel'dovich's Phase Conjugation bring us to a holistic perspective. With these advances the awesome power of the observer operating in space and time begins to make itself felt.

The photon trajectory and its wave front are always orthogonal, the ideal wave front being tangent to the photon's resultant trajectory. In free space the "photon" and the "wave front" both travel at *c*. Their constant interaction gives rise to the "c^2" that crops up all over in quantum mechanics. This expresses the idealized orthogonal space created as an abstract "square plane" by the particle and wave forms of the photon. The holographic bubble and square plane propagation properties of EM radiation are what give us the back-propagated complex conjugate "advanced" wave particle of the photon.

In our example of the klystron wave guide, the propagating wave is deliberately obstructed so that the wave must follow the channel assigned to it. This means that the photon as a particle (group wave packet) and the photon as a wave front (phase wave packet) interact with the wave guide's inner surface, echoing back and forth down the chamber. This appears to distort the resultant relation of the photon particle and its wave front so that the photon seems to pass slower down the tube while the wave front whips back and forth at superluminal speeds. Nevertheless, the truth is that the orthogonal relation is always there and the photon with its wave front always still translates at speed *c*. The resultant just looks zigzaggy, but it is an illusion due to a specially prepared observer viewpoint. Study the klystron drawing I gave when I first introduced the "Velocity Equation".

Photons and Special Relativity

In the undefined world of mental possibilities an exchange of photons is just an exchange of energy. The energy moves from one place/time in undefined awareness to another place/time in undefined awareness. Undefined awareness has no opinion about where it

begins or ends. An event is just an event. Photons do not interact with each other. They can pass right through each other, undeterred and unaffected (although what you perceive may be affected by positive or negative wave interference when the waves are summed).

In our physical world an electron pair acts as a secondary source and a terminal, -- an emitter and an absorber --, for the photon pair. Photon partners also act as a pair. The photon's partner is its "antiparticle". But if they travel together, don't they mutually annihilate? Yes, they do. But the products of the annihilation are just another photon-antiphoton pair, because photons are at the bottom of the "annihilation chain" and may not annihilate. **They are the phenomenalization of undefined awareness.**

Principle: EM photons are objectivized awareness. Attention particles are subjectivized EM photons. We perceive objectivized EM photons via their partners, attention particles (anti-photons), in the form of light, heat, pressure, and other sensations as they deliver our own resistances back to us as experiences. All mental and physical sensations occur via exchange of attention particles and EM photons. Consciousness is a stream of attention particles interacting with photons. Since they all always go at *c* relative to each other, they might as well not be moving.

When Einstein as a young man began studying the nature of light, he imagined that he could travel along with the light and observe it from the light's reference frame. Physicists say he was just imagining, because his body could not go at such a speed. That limitation was not known for sure back then, and still is not certain. Furthermore, Einstein's imagination could go at any speed, since it did not have any mass to deal with. What he would have seen is photon-antiphoton pairs pulsating at light speed but not going anywhere. Of course, every time he looked at a photon pair, he would absorb it. He would become it and be it, so it was really his own consciousness pulsating as thoughts.

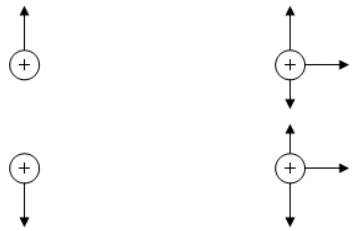
The photon and its anti-partner look just alike (same speed, same phase, and no charge). Which is which is relative to the observer. The pair interaction makes the photon appear to vibrate as it travels instead of propagating in a purely straight line. (We do not know for sure how a photon "propagates", because we can only infer what it does during transition through space-time by means of its interaction with electrons at the termination of its transit. Einstein would only be able to absorb and become the photons he wished to observe. When we get to the true nature of light, the propagation problem disappears.) Photons appear to propagate in the conjugate dimensions of the source (emitter) and observer (absorber); they also oscillate in the dimensions of electrical and magnetic resistance (euphemistically called "permittivity" and "permeability", terms that imply a resistive aether – the observer's own resistance in awareness to experience). The path vector from source (Poynting vector -- the directional energy flux density of an EM field), electric, and magnetic dimensions of "light" define 3-space, and the observer's attention defines time by calculating the back-propagation gap between source and terminal. The frequency of the oscillation determines the clock's tick as well as the energy translated. In this way photon pairs travel along apparently annihilating and recreating each other,

carried by their linear momentum at the speed *c* until an electron or positron absorbs them. Then they may seem to stay “annihilated” for a while. Their energy is transformed into a component of the electron's kinetic energy above its rest energy ground state, and the photon reflects back the way it came via its anti-photon partner -- so absorption and emission are really misnomers, since the energized electron has the photon riding on it like a cowboy riding his horse.

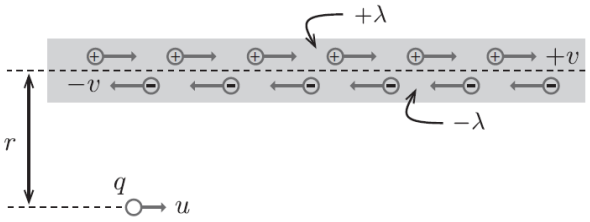
The higher the energy (frequency), the faster the clock ticks. The lower the energy (frequency), the slower the clock ticks for the observer's consciousness. When an emitter and absorber separate from each other at high relativistic speed, the photon clock appears to slow down when observed by someone in a relatively inertial frame (compared to her local clock) in order to maintain energy equilibrium with the constant speed of light.

This is what Einstein discovered in his theory of Special Relativity. (N.B. Special relativity is special, because it only treats bodies in constant relative motion that are not subjected to any acceleration.) Einstein noticed that in a relativistic frame characterized by uniform velocity, you are unable to tell your frame's velocity unless you look outside the frame to compare with another frame. Without reference to "outside", it is as if everything is at rest. Einstein assumed that the laws of physics would be the same for all relativistic frames. Newton saw this principle at the basis of his mechanics and his formulas were set up to be covariant in Galilean space, but the development of electromagnetism in the late 19th century precipitated a crisis, because light did not behave that way. Measurements showed that light speed appears to be an absolute universal constant regardless of the observer frame.

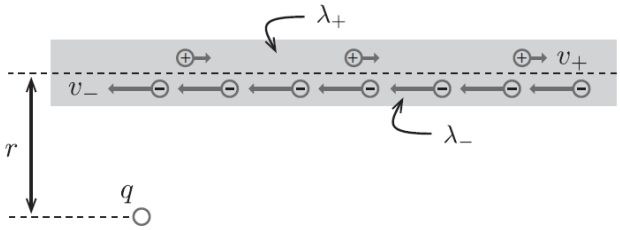
Furthermore, Maxwell showed how light, electricity, and magnetism are all components of a single electromagnetic whole that moves at speed *c*. A curious feature of this ensemble relation is that you can have an electrical phenomenon and a magnetic phenomenon interacting so that from one observer viewpoint you have an electric force $F_E = q\boldsymbol{E}$, and from another observer viewpoint you have $F_B = q\boldsymbol{v}\times\boldsymbol{B}$, and the observed motion due to the force is identical for both observers, but the equations from the two different viewpoints are not covariant, but look like different laws! The full force equation is $F = q(\boldsymbol{E} + \boldsymbol{v}\times\boldsymbol{B})$, so if there is no velocity ($\boldsymbol{v}$) relative to the observer, the magnetic component disappears and only an electric component remains. Under certain other conditions of motion relative to the observer the electric force “disappears” and only a magnetic force remains. Both observers agree on the physically observable effects of the force, but seem to explain them differently. The trick is that light is electric and magnetic, so you must consider both aspects together to get the whole picture and integrate it with relativistic electromagnetism.



In the sketch above on the left two equal charges at rest relative to the observer experience only an electrical repulsion. The same two charges in parallel motion relative to the observer exhibit a magnetic "attractive" force that must be subtracted from the electrical repulsion.



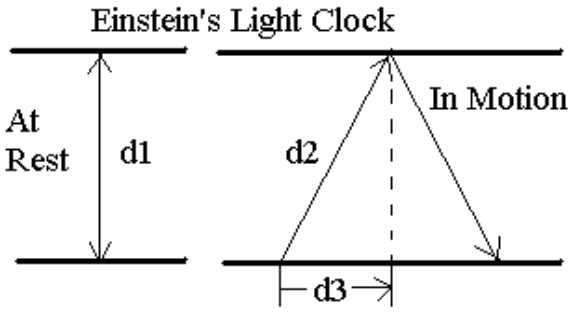
From the viewpoint of the observer at rest with respect to the wire with a current drawn schematically above, the positive and negative charges cancel and there is no net electrical force on *q*.



However, if the observer moves along with *q* at velocity *u* and is thus at **rest with respect to *q***, the velocity of the positive charges in the wire are less than that of the negative charges, plus the negative charges appear denser due to Lorentz contraction. This results in a net negative charge on the wire so that it exerts a force on *q*. One observer sees a magnetic force, and the other observer sees an electric force. Actually it is always an electromagnetic interaction with different values for different parameters depending on observer viewpoint. Interestingly, the magnetic aspect along with the constant speed of light reveals the principle of special relativity that Einstein formalized after studying the insights Maxwell's electromagnetic dynamics brought to Newton's laws of mechanical motion.

If we assume that the speed of light is constant for all observers as Einstein assumed based on these studies, then light's oscillation frequency (and hence energy) must shift to compensate for differences in uniform motion between the observer and his observables and Newton's laws of mechanics have to be adjusted to compensate. In special relativity Einstein only deals with the issues of uniform motion, and leaves accelerating systems to general relativity. Einstein imagined a light clock that bounced a light signal between a pair of mirrors. The round trip between the mirrors counted as a clock tick. (This resembles a resonant cavity with a coherent standing wave.) If we made another identical light clock, synchronized it with the first clock, and then moved the second

clock at close to light speed normal to its timing beam, an observer in an inertial frame watching the clock go by would see that the light beam had to zigzag in his frame as it reflected back and forth from the mirror, whereas his stationary "standard" clock just went up and down, telling “proper” time. To the observer traveling along with his moving clock, nothing would seem to change as far as his clock was concerned, and to him his clock would also tell proper time. But to the outside observer who is watching the moving clock from his position at rest, the fast moving clock would appear to slow down. (The observer going along with the moving clock would also see the resting clock that he had passed slow down, because the uniform motion is relative.) This behavior is observed commonly with the frequency shifts of fast-moving astronomical objects and subatomic particles. The spectral lines of starlight are shifted, and the decay rates of fast moving particles appear slowed. Einstein's theory seems to explain these phenomena very well. Einstein, however, did not explain what influences may occur after the two clocks are synchronized and then the second one is accelerated to relativistic velocity. Here is a sketch of the two identical and "synchronized" light clocks, one at rest and one in motion.



* ($d_1 = c\ \Delta T$), where ΔT is the time period needed for a photon to go distance d_1.
* ($d_2 = c\ \Delta t$), where Δt is the time period for the distance observed by observer.
* ($d_3 = v\ \Delta t$), where v is a velocity slower than c for the velocity of the clock.
* $d_2^2 = d_1^2 + d_3^2$; $(c\ \Delta t)^2 = d_1^2 + (v\ \Delta t)^2$; $d_1^2 = (c\ \Delta t)^2 - (v\ c\ \Delta t)^2 / c^2$.
* $d_1^2 = (1 - v^2 / c^2)(c\ \Delta t)^2$.
* $\boldsymbol{\Delta t = (d_1 / c)\ (1 / [1 - v^2 / c^2])^{1/2}}$. [The Lorentz factor $\gamma = (1 / [1 - v^2 / c^2])^{1/2}$.]
* $\boldsymbol{\Delta t = (c\ \Delta T / c)\ \gamma}$
* $\boldsymbol{\Delta t / \Delta T = \gamma}$

Here we are substituting distance traveled per unit of time to show graphically how the clock's ticking dilates relative to an inertial observer, because when the clock moves, $\Delta \boldsymbol{t}$ has to be larger than $\Delta \boldsymbol{T}$. When the moving clock moves sideways, d_2's path gets stretched out diagonally relative to the outside observer's perception of d_1, which is at rest from his viewpoint. Thus the moving clock #2 appears to tick more slowly for him than his clock #1 that is at rest from his viewpoint. From its structure the Lorentz factor $\gamma = (1 / [1 - v^2 / c^2])^{1/2}$ only becomes significant at speeds that begin to approach c. At slow speeds the factor is very close to 1, so d_1 and d_2 are almost equal.

This time dilation $\Delta t - \Delta T$ at high velocities for inertial observers is the same type of phenomenon as the distortion of group waves and phase waves that we saw taking

place in a klystron wave guide. The only difference is that the wave guide has a long stationary tube guiding light photons and wave fronts, whereas the light clock has a tube that moves along sideways with the oscillating photons and wave fronts bouncing between the walls.

The findings of special relativity are:

* $\Delta t / \Delta T = \gamma$, where ΔT is a "proper" time interval on a stationary clock and Δt is the same interval on a moving clock as observed by someone at rest relative to the stationary clock. The moving clock appears to run slow: $\Delta t > \Delta T$ when viewed from the stationary clock frame.

* $\Delta L / \Delta l' = \gamma$, where ΔL is a proper length at rest, and $\Delta l'$ is the same length viewed by a person in motion moving parallel to the length. Also, a person in the rest frame can view a proper length $\Delta L'$ in motion and it will appear foreshortened into Δl in the direction of motion.

* $m / m_o = \gamma$, where m_o is the rest mass and m is the mass in motion. Of course, in this case the observer at rest has no way to "measure" the moving mass, but he can measure how much energy it takes to accelerate a relativistic particle in a particle accelerator.

Let's now imagine that the d1 clock is at rest and the moving clock is on a space ship that has the same size d_1 clock on board. The light clock at rest ticks off its unit length in 1 unit of time with a mirror that sends the light at 90 degrees toward the moving ship, and so the d_1 light clock on the ship also ticks off its unit length in 1 unit of time relative to the captain of the ship who stands at rest watching his shipboard clock tick. However, his ship is going at twice the speed of light ($2c$). He moves past the stationary clock just as that clock starts a tick cycle. By the time it ticks sending its flash to the captain, his ship has already gone 2 units of length past the stationary clock and the signal for the tick of the stationary clock will take over 2.236 units of time, by which point his ship will have gone past the point where he could see the flash of light from the tick. He outruns the signals from the stationary clock. The man by the base of his stationary clock observing the ship fly by will experience a delay for the tick from the ship (reflected back from the shipboard clock. After slightly over 2.236 ticks on his stationary clock the first tick from the shipboard clock will arrive. When they arrive, the color will be Doppler shifted toward the red end of the spectrum.

The mass of the ship will appear greater to the observer watching it pass by than it does to the ship captain who is at rest relative to his ship – if he could somehow measure it. The captain can increase his speed until he goes much beyond the speed of light, because he is always at rest relative to his ship, and so is his fuel. We at rest on earth are not able to even accelerate a single electron past light speed, because we operate on it from our rest frame that is external to the moving electron, which means that the electron's mass appears to increase as it approaches light speed and would take endless amounts of energy for us to push it up to light speed from our observer perspective.

The observer left behind "at rest" as the ship zooms off into deep space will see the ship fade into the red, infra-red, and so on into the low end of the spectrum, the frequency downshifting by the ratio $f'/ f_o = \sqrt{(c-v/c+v)}$. Signals also will be delayed. An approaching ship will be blue-shifted by the ratio $f' / f_o = \sqrt{(c+v/c-v)}$. Viewed from a transverse perspective there is only the time dilation.

We can even dispense with the light clock and just use the photon itself as a light clock. It is generally assumed that the photon naturally oscillates as a wave in the vacuum through which it travels. Nobody explains how or why it does this. I have already suggested a model. I also suggest that the observer's resistance causes this oscillation in his non-local awareness. The whole space between the charged source and terminal particles that are exchanging energy vibrates as a temporary non-local space-time standing wave. The energy of the wave is fixed by the quantum mechanical nature of the electron orbits that form the terminals. However, the wave form -- and hence the space-time -- appears distorted by the relative kinetic motions of the terminals. If an orbiting electron releases photons at a characteristic wavelength, the motion of the atom or molecule ensemble in which the electron participates adds other properties to the wave. To compensate, the wave appears to modify its wavelength rather than its velocity. As we mentioned, light from a receding object is red-shifted, and light from an approaching object is blue-shifted. This is the electromagnetic Doppler effect, similar to the way sound is Doppler distorted when it emanates from rapidly approaching or receding vehicles.

In spite of this wavelength shift for the "outside" observer, the observer traveling with the light clock always sees the light move at *c*, and the inertial observer also sees the light move at *c*. All observers experience light from any specific perceivable source to be moving at *c*, regardless of the relative motions of their reference frames. The frequency of the light appears to shift depending on the observer's viewpoint.

A slight problem with the clock experiment is that the time dilation appears only to an observer watching orthogonally to the path of the moving clock. He is unable to see the light beam in the clock, so he can only somehow detect the ticks with each cycle of the clock. However, as the clock moves far away from him, he can only see the clock as a vertical space between mirrors. He can't see the light beam as it moves back and forth in the clock, but the ticks will still seem to slow down. This corresponds to the red-shift astronomers observe when watching stars move away from us and blue-shift as they move toward us. However, remember that to the astronaut moving with the clock, his own clock stays unchanged, and for him the clocks by the Earth-bound observer seem to tick more slowly.

A Thought Experiment that Leads to a Compassionate Twin Paradox.

The usual twin paradox thought experiment in special relativity involves one member of a pair of twins named Joe setting off at nearly the speed of light on a distant journey through space. As he leaves, his twin called Moe who is left at home sees brother Joe's clock slow down due to the very high speed of Joe's space ship. When Joe returns, he

has aged only a few months, while his landlubber twin Moe has grown old. This bit of pseudo-science fairy tale has been liberally served up in textbooks and magazines for decades as an example of how perplexing special relativity is. Actually it is simply propaganda to mess with your mind.

The first problem with the example is that Joe accelerates and turns around, so both his speed and direction are not constant during the event interval. This means the example has nothing to do with special relativity in which all parties must be in fixed frames relative to each other with no relative changes in speed or direction. It gets deeply involved with general relativity, gravity, and inertial accelerations. To rectify this we imagine that mankind now has a series of big space stations out beyond the Oort cloud in a big Lagrangian area between our galaxy and Andromeda, so gravity is not an issue. Joe lives in station A, and Moe lives in station B. At some point Joe gets transferred to station C.

Stations A, B, and C are equidistant. The shuttle ships have a cruise speed of .866 *c* with a short period of acceleration and deceleration at each end of the journey. For his trip Joe will accelerate to top speed and then coast for a little over a month over a distance of one light-month at the constant cruise speed, pass station B, and then continue coasting for another light-month distance at cruise speed heading on toward station C, then decelerate and land. Thus during the more than two month coasting period Joe and Moe will be moving relative to each other at a constant velocity of .866 *c*, assuming that the three stations are motionless relative to each other. Thus we have over two months of relativistic travel with no change in speed or direction, and general relativity is uninvolved.

Second, we are told that space and time are truly relative to the observer. Yet we are told that Moe sees Joe's clock slow down, but we often are not reminded that Joe also looks back and sees Moe's clock slow down by the same relativity principle. If both Joe and Moe see the brother's clock slow down by the same amount, then they both will see each other age the same amount, and everything is fine and normal, except for the fact that they will both see apparent differences in time lapse as a result of the relative motion.

To view the problem from our simpler space station example, we suppose that both Joe and Moe have identical Einstein light clocks that bounce photons back and forth between mirrors. Joe's mirrors are arranged so the photons bounce orthogonal to his direction of motion. To be consistent, Moe's do also. They can't see each other's photons, but each clock keeps a local digital count of its ticks and also flashes a bright light between the stations at each tick. Joe's light flashes a special signal to Moe when he reaches cruise velocity and begins his long coast to pass station B. That signal travels at *c* to Moe at station B, and he records that against the tick count on his clock one month after Joe sent it. The light signal travels one light-month in one month to reach station B. No problem here. Moe also sends tick signal flashes from his light clock off toward Joe.

Moe will observe that there is a strong and steady blue shift to all Joe's light signals from

the moment he begins his coasting segment. Prior signals had gradually shifted from the standard color to the bluer coasting color of an oncoming ship. The bluer signals have a higher frequency and a shorter wavelength, just like the horn from an oncoming train sounds a higher note. Joe from his side will observe that Moe's clock signals also shift to a bluer color and then stay at that color when he begins coasting. When Joe coasts past Moe at station B, Joe will by his own clock and in his own consciousness have spent more than a month coasting, but Moe will find that a much shorter time has elapsed from when he received the signal of Joe's onset of coasting to when Joe zoomed by station B. However, in absolute time, Joe and Moe have both aged the same amount, and their clocks have both ticked the same number of times. Moe just saw Joe's clock tick faster for a shorter period of time from his viewpoint on station B. Moe realizes that Joe's start-of-coasting signal took a month to reach him, and so the timing signals from Joe's clock during that month got all scrunched up into the short interval from when Moe got the coasting signal to when Joe flew by him. Joe from his viewpoint knows when he started coasting and records it from his own shipboard clock, so he sees Moe's clock ticks scrunched for over a month of his local clock's time. But let's see what happens next.

At the moment when Joe coasts by Moe at station B, Joe's clock ticks about the same as Moe's and both clocks give off about the same standard color tick signal lights for a brief interval. However, once Joe zips past Moe and heads on toward station C, his tick signals start to stretch out and the color starts to turn redder than the standard signal color – just like the way a train's horn suddenly shifts down to a lower note once the engine passes you. Joe goes on coasting for over another month (by his clock) as he travels another light-month toward station C, and then begins his deceleration to land on station C. When he ends his coasting segment of the voyage, he flashes off a special signal to Moe back at station B. Joe's clock has altogether ticked off over 2 months of smooth coasting. However, the ticks from the second half of the journey that Moe receives from Joe will be stretched out. The final special signal sent by Joe to Moe when Joe stops coasting and starts deceleration will take one light month to reach Moe, but the signal is sent off over a month **after** Joe passed by Moe, so it will take altogether over two months after Joe flew by Moe to reach Moe. During that time Moe will receive the stretched out low-frequency large wavelength tick signals from Joe's clock. It will seem to Moe as if it took Joe well over two months to reach station C after passing B even though he flew by at a constant .866 *c*.

From Joe's point of view, a whole lot of Moe's ticks were crunched into the period of over a month as he coasted toward B, as if Moe was living at higher than normal speed. Once Joe passes B, Moe's clock slows way down and Moe seems to Joe to be living in slow motion for over a month. What Joe sees as Moe's faster and slower living time frames exactly match and cancel out to be a net normal absolute time interval. By the time Joe reaches station C, the expected time interval has elapsed both for Joe and for Moe. When Joe and Moe reunite at some point on station B or station C, they both will have aged the same amount according to their biological clocks and in accord with the "clock" of absolute event time. The relativistic shifts of space and time are temporary distorted artifacts of observers moving in different reference frames. They disappear

once everybody realigns to the same absolute event time reference frame.

The lesson we learn from this is that events are absolute and real, but can appear to occur at different speeds, times, and/or locations depending on the observer's relative motions and local viewpoint. Many kooky misconceptions have proliferated from the pens and mouths of scientists, pseudo-scientists, sci-fi buffs, and political spin artists. Nevertheless, jetlag is a real phenomenon, and so is the time lag brought on by a long journey. Explorers of the past, present, and future know this full well. We have dealt with jetlag in our current age and the gaps of time lost to long voyages. We will learn to deal with off-planet gravity lag, circadian disruption, rapid inertial shifts and other realities, -- but fortunately we need not worry about the twin paradox for now. Nevertheless, when we get to the era of time travel, we will inevitably face some issues, and I predict that human consciousness will be much more flexible by then. I will briefly introduce some of the technical issues regarding time travel in a later essay of this series. For now, contemplate what they might be and how we might address them.

Here is an example of the problem presented in **Wikipedia**, "Twin Paradox". My comments are in brackets and boldface.

Consider a space ship traveling from Earth to the nearest star system outside our solar system: a distance d = 4 light years away, at a speed $v = 0.8c$ (i.e., 80 percent of the speed of light).

(To make the numbers easy, the ship is assumed to attain its full speed immediately upon departure—actually it would take close to a year accelerating at 1 g to get up to speed.)

The parties will observe the situation as follows:

The Earth-based mission control reasons about the journey this way: the round trip will take $t = 2d/v = 10$ years in Earth time (*i.e.* everybody on Earth will be 10 years older when the ship returns). The amount of time as measured on the ship's clocks and the aging of the travelers during their trip will be reduced by the factor $\epsilon=\sqrt{1-v^2/c^2}$, the reciprocal of the Lorentz factor. In this case $\varepsilon = 0.6$ and the travelers will have aged only $0.6 \times 10 = 6$ years when they return. **[The critical point is the notion that the time of travel for those on the ship will be reduced by the reciprocal of the Lorentz factor. In the first place, there is no evidence that supports the shrinking of space during motion. That would be equivalent to increasing the ship's speed, which would also increase its mass, which would reduce its ability to reach such a speed. Let's just stick with the notion that for Earth-based observers the 8 light-year voyage will take 10 years, assuming no time spent at the destination. The other calculation is their hypothetical imagination. The Earth people know that the travelers will always be at rest relative to their moving frame, and at a speed of .8 *c* the journey takes 10 years. "The amount of time as measured on the ship's clocks and the aging of the travelers during their trip" refers to how the earthbound people see the ship, not the reality on the ship. As the ship moves away earthbound ones will see red shift, and as it returns they will see blue shift. The two will mutually offset. Note that signals on the way out not only get red shifted, they take longer to arrive because of**

the changes in distance as the ship moves. By the time the ship reaches 4 light years out, those red-shifted signals will take 4 years to reach Earth at light speed, by which time the ship will already have gone halfway to Earth. Then all the wavelengths from the returning voyage of 4 light years distance will have to be scrunched into the last 5 years of the return trip for the Earth observers' viewpoint, since the real distance is 4 light years and the ship travels at .8 *c* and light travels at *c*. So the ship's crew as seen by earthbound observers will age very rapidly during the last 5 years of the trip so the crew can catch up with their earthbound brethren.]

The ship's crew members also calculate the particulars of their trip from their perspective. They know that the distant star system and the Earth are moving relative to the ship at speed v during the trip. In their rest frame the distance between the Earth and the star system is $\varepsilon d = 0.6d = 2.4$ light years (length contraction), for both the outward and return journeys. Each half of the journey takes $2.4/v = 3$ years, and the round trip takes $2 \times 3 = 6$ years. Their calculations show that they will arrive home having aged 6 years. The travelers' final calculation is in complete agreement with the calculations of those on Earth, though they experience the trip quite differently from those who stay at home. **[The ship's crew is at rest in their own coasting frame and sees Earth and their destination as if moving. In the crew's rest frame the destination approaches with blue shift and Earth recedes with red shift on the trip out. The reverse is true on the trip home. From their rest frame the number of light waves exchanged with home and destination are equal, because the light is the same from all parties. The light moves at *c*, and only appears shifted in wavelength due to the relative motion. The spatial displacement does not change, nor does the light change. Only the frequency or wavelength perceived by the observer changes. On the way out, destination clocks seem sped up, but on the way back, they seem slowed. On the way out Earth clocks seem slowed, but on the way back, they seem sped up. If the loop is closed, it all balances out.**

If twins are born on the day the ship leaves, and one goes on the journey while the other stays on Earth, they will meet again when the traveler is 6 years old and the stay-at-home twin is 10 years old. The calculation illustrates the usage of the phenomenon of length contraction and the experimentally verified phenomenon of time dilation to describe and calculate consequences and predictions of Einstein's special theory of relativity. **[Notice that the "phenomenon" of length contraction is not said to be experimentally verified. If it exists, it affects only an external rest frame observer's sideways view of a moving object, and not space itself. It is only an optical illusion seen by a biased observer, and is not a real artifact of event space-time.]**

The paradoxical aspect of the twins' situation arises from the fact that at any given moment the traveling twin's clock is running slow in the earthbound twin's inertial frame, but equally the earthbound twin's clock is running slow in the traveling twin's inertial frame. The resolution is that the earthbound twin is in the same inertial frame throughout the journey, but the traveling twin is not: in the simplest version of the thought-experiment the traveling twin switches at the midpoint of the trip from being at rest in an inertial frame with velocity in one direction (away from the earth) to being at rest in an inertial frame with velocity in the opposite direction (towards the earth).

[Oops! The writer here claims that "the earthbound twin is in the same inertial frame throughout the journey, but the traveling twin is not". Unfortunately for the writer of this "explanation", when the traveler switches inertial frames, the earthbound twin also switches frames. Motion is relative according to special relativity, so the traveling twin from his rest frame sees that the earthbound twin "switches at the midpoint of the trip" and starts moving in the opposite direction as soon as the traveler changes his direction of motion. In his frame he is at rest, so the earthbound twin moves away and then moves back. Thus it all balances out. The only way for there to be a difference in age is if the number of waves transmitted and received is different. Since the motion is always less than light speed in the example, this is impossible. Light speed between the two motionless travel points, position of the ship, its fixed velocity, and a standardized signal frequency all determine the number of light waves. The constant relative motions of the various observers can only rearrange the density of the waves, not their number. Light speed is constant. If the total number of light waves exchanged equal for each person, the final aging at the end of the voyage is the same for both.]

Long-lived Muons?

Consider the case of lab tests where slow moving muons decay at an average clock rate of 10^{-6} s, but last about 12 times that when batted up to near light speed by a cosmic ray particle. This example of time dilation seems to make sense, because the observer in the lab is almost at rest relative to the slow lab muons, and the observer outside clocking muons in the wild as they descend from the upper atmosphere is still in his own rest frame, but the muons have been shifted into a rapidly moving frame relative to the observer's frame. Since they are approaching the observer, the observer seems to approach them and the observer's clock seems to speed up relative to them. The scientist doing the measurements does not know exactly where the cosmic particle strikes the air molecule to make a muon. All that is extrapolated. The cosmic rays could generate muons anywhere in the atmosphere. Also the effect is mostly due to general relativity as they move through the Earth's gravitational influence. (For a video of an experiment on relativistic muon decay, see http://www.scivee.tv/node/2415. In the video they call muons "mu mesons", an old term used before it was clear that the particles are leptons, not mesons.)

If we go back to Moe and Joe regarding the supposed special relativity effect on muons, consider the first half of the coasting period as Joe approaches station B as a rapidly moving muon. Joe moves at .866 *c* for 28 days, and we will suppose that he flashes a signal once every 4 light days, a total of 8 signals, the last of which he sends as he flashes by station B. His first signal takes 28 light days to reach station B. When it reaches Moe, Joe is already 24.248 light days into his trip and has less than 4 light days left to reach B. Thus his other seven signals reach Moe when he has gone 20.784 light days from lightday 4, 17.32 light days from lightday 8, 13.856 light days from light day 12, 10.392 light days from light day 16, 6.928 light days from light day 20, 3.464 light days from light day 24, and 0 light days from light day 28 – in other words, just as he passes Moe. All signals travel at *c* from the time they are sent, while Joe keeps moving along at .866 *c*, so that it takes him about 32.333 days to reach station B.

On day 4.6189 of his journey, Joe sends signal 2 that takes 24 days to reach Moe. On day 9.237875 of his journey, Joe sends signal 3 that takes 20 days to reach Moe. On day 13.8568 of his journey, Joe sends signal 4 that takes 16 days to reach Moe. On day 18.47575 of his journey, Joe sends signal 5 that takes 12 days to reach Moe. On day 23.094688 of his journey, Joe sends signal 6 that takes 8 days to reach Moe. On day 27.713625 of his journey, Joe sends signal 7 that takes 4 days to reach Moe. On day 32.3325635 of his journey, Joe sends signal 8 that takes only a split second to reach Moe.

All of the signals reach Moe before Joe does except for the 8th signal that arrives just as he does, because he has arrived. Joe has spent 32.333 days coasting, and Moe has spent 32.333 days waiting. What changes is that Moe experiences Joe's signals at a much higher frequency, but with a big lag time before he starts receiving them. Moe gets the first signal when Joen will arrive in about 8 of Moe's days. So the remaining 7 signals come in during that time frame. Moe sees Joe's clock go very fast, but knows that is an illusion caused by the light speed time delay. It makes no sense for the clock of a muon coming toward you to slow down. It clearly seems to speed up, but that is an illusion due to the speed of light lag time experienced by the ground-based observer. If the muon goes at .99999% of *c*, then it reaches the observer before its normal resting half-life clock has a chance to tick, traveling as much as 3 million meters. At 600 thousand meters you are already in the exosphere. Muons can scatter from cosmic rays anywhere during the trajectory.

If Joe travels at *c*, then he arrives at the same moment Moe receives his first signal from Joe. All his other signals from the ship (including Joe and the ship) also arrive at the same moment. Thus it is as if no time elapsed for Joe, but 28 days elapsed for Moe. The truth is that Joe spends 28 days in his ship, and Moe waits 28 days to hear from Joe, and then Joe zooms by and flashes at him. Moe and Joe both pass 28 days. At his speed of .866 *c* Joe takes longer to reach station B, arriving in about 32.333 days. All 8 of his signals are scrunched into the 3.752 light days from when his first signal reaches Moe. He coasts about 2×10^{16} meters.

Atomic clocks on satellites and on Earth have to be adjusted periodically to deal with the time dilation effects of the satellites' high speed, constantly changing direction, and gravitational effects, which are mostly due to general relativity. Thus the data is said to confirm Einstein's notions of time dilation. But recall, that for each of the muons, satellite clocks, and particles accelerated in accelerators -- **relative to their own frame that is at rest**, the clock runs as usual and the mass is unchanged.

Along with time dilation there is also a corresponding contraction of length in the direction of motion (called Lorentz contraction: $\Delta L \,/\, \Delta l' = \gamma$). Lorentz conceived this contraction to exactly match the time distortion so that measurements of the speed of light could not detect any motion of an Earth-bound instrument with respect to a supposed absolute reference frame of the universe called the aether. Experiments on light speed showed that light apparently is not affected by the Earth's motion through space. Einstein then incorporated the Lorentz transformation into his theory of special relativity.

* $x' = (x - vt)\,\gamma$, where x is the system at rest and x' is the system in motion, velocity v.

The apparent compression of waves in the direction of motion corresponds to an increase in energy (EM energy being a function of frequency) and therefore an apparent increase in mass. The mass increases without limit as the velocity approaches c.

* $m = m_o\,\gamma$
* $p = mv = m_o v\,\gamma$ (p is for momentum)

In terms of energy we must add the rest mass energy $m_o c^2$ and the relativistic kinetic energy K to get the total energy E. The relativistic energy is then

* $E = K + m_o c^2 = m_o c^2\,(\gamma + 1)$.

The Lorentz factor gamma suggests that as the kinetic velocity v approaches c, the energy required for a mass with that velocity approaches infinity. Hence, it must not be possible for a physical body with mass to reach or exceed light speed. If you increase the speed of an electron in a particle accelerator to high relativistic speeds, you begin to need thousands of times the energy required according to Newton's laws to continue accelerating the electron. The kinetic energy component at relativistic speeds dramatically increases the apparent mass of the electron.

However, there is a trick of observer viewpoint here. K is calculated from the viewpoint of an observer watching at "rest" from down on Earth (or in a separate frame from the particle in the accelerator). Our intrepid cosmonaut is at rest relative to his flying saucer craft as he heads from Earth toward a far distant solar system, regardless of what speed his craft is moving. (For simplicity we assume that his inertial guidance disallows the G-forces from rapid accelerations to higher speeds.) When the craft moves slowly, the Earth observer sees his craft in normal color. When he goes at relativistic speeds away from Earth, there is Doppler shift and his craft seems to become redder when viewed from Earth. Eventually the Earth observer will require a radio telescope to see the craft. Once the craft goes at light speed or beyond, our Earth observer will lose the blip from his telescope screen. He will also lose communication with the cosmonaut as if he fell into a black hole. All the while the astronaut will lounge comfortably in his craft, his clock will seem to run normally for him, and colors in his ship will also be normal to his vision. There is no reason in principle why he is unable to go faster than the speed of light by simply continuing to accelerate in increments from his own rest frame. After each impulse of acceleration he coasts at rest in a new inertial frame with respect to his ship. The Earth observer eventually will receive the delayed signals from the craft.

As far as the increase in mass is concerned, the change is only imagined by the Earth observer, since he has no way to measure it. The cosmonaut will feel no increase in mass as he goes at various ever faster speeds, because he remains at rest relative to himself and his craft. He feels only the slight impulses at each instant of acceleration. The observer on Earth will see that the space craft paradoxically seems to decelerate as it accelerates to faster and faster speeds, as if it were trying to push along a greater and

greater mass. This is due to signal delay, not mass shift. Eventually, when the astronaut reaches light speed, the Earth-bound observer will "see" that the space craft has stopped moving, as if a great infinite inertial mass has dragged it to a halt. He will then not even see the craft, because its wavelength will have flatlined. At light speed time stops. From that reference frame all is immortal and eternal, and all phenomena are one inseparable whole that might as well be an eternal continuous but scintillating “flash” – except that an eternal flash is not a flash, and it is hard to say exactly what it is, since it is undefined until an observer starts to select biased local viewpoints. Although the wavelength has flatlined, eventually it still arrives, but with its energy (frequency) so attenuated that it may not be detectable with instruments.

To travel at *c*, a particle must convert itself back into radiation mode by unfurling its curled up photon energy into pure linear momentum. This seems difficult, but is actually very easy. We can see that happen as the wavelength stretches and the frequency drops. It is a kind of cosmic relaxation. The universe is completely lazy, and even biased phenomena end up taking the path of least action.

Another way of looking at it is that the apparent increase of mass-energy at the front end of a moving particle or spacecraft is balanced by a corresponding loss of mass-energy at its tail end. So the Earth observer watching the craft recede sees the craft lose mass-energy until it becomes massless when it reaches *c*. From then on it can move as a phase wave as fast as it wants. That is to say for bodies moving apart there is time dilation and wavelength stretching. The wave stretching is like this.

* $\lambda_l = [(c + v) / (c - v)]^{1/2} (\lambda_o)$. (Longitudinal)
* $\lambda_l = \gamma \lambda_o$. (Transverse)

The photon performs the **same number of oscillations** as it moves between emission and absorption for all observers in different frames, but for the observer who sees a body moving away from him, the wavelengths seem to get longer to compensate for the greater distance. The process reverses when bodies move toward each other. If a body moves at $v = c$, then the wavelength it emits behind it's trailing edge becomes infinite in either longitudinal or transverse mode and the object becomes invisible to an observer watching it move away. It has no energy, and thus becomes invisible. The problem here is something that plagues physics: equations blow up when variable quantities go to zero or infinity. In this case it is not really a problem, because, for the observer at rest on Earth, when the body in motion reaches velocity *c*, it may as well have lost all its mass. The observer can only detect EM radiation from the receding body, and that radiation has gone flat, indicating zero energy, and for all intents and purposes also zero mass. If the astronaut looks back at Earth, he also sees Earth fade out as he reaches *c*.

What happens when our astronaut moves on to speeds greater than *c*? Imagine that he reaches a velocity of $2^{1/2} c$ (about 1.4142 *c*). The Lorentz factor becomes

* $1/(1 - 2 c^2 / c^2)^{1/2} = 1/(-1)^{1/2} = \pm i^{-1}$.

The "signal" from the cosmonaut's ship to Earth becomes $\pm i = \lambda_o / \lambda_1$ and has gone into the imaginary realm for the Earth-bound observer. The ratio of the wavelength at rest to the wavelength in motion is the square root of -1. The ratio of rest mass to moving mass becomes $\pm i = m_o/m_1$. All superluminal velocities will involve some multiple of *i*. Physicists simply toss this result aside even though it sits there in Einstein's equation, as clear as day. **(Not only do we have imaginary results, but the square root of the dimensionless Lorentz factor always has both a positive and a negative value and the negative root is ignored.)** If v is extremely small, then one solution is the negative of the classical solution. In terms of time, it means the time period of the event is reversed, which makes sense in terms of our phase conjugation analysis and of course Newton's third law (equal action and reaction). At relativistic speeds the time dilation also works in both directions. However, what does negative mass mean? Perhaps mass increases from one perspective while simultaneously decreasing from another perspective. For example, when v = "0", the body is at rest. The kinetic energy is then 0, and because the gamma factor equals 1, thus the total energy equals the rest energy and nothing is left over as kinetic energy. No problem. However, the gamma factor in this case is also -1. $E = mc^2$ (total energy), and the negative solution gives $E = - m_oc^2$ with a kinetic energy of $K = -2\ m_oc^2$. This suggests to me that a particle at rest energy implies the existence of its antiparticle with a kinetic energy difference of two rest energies, because it lies on the other side of the Dirac sea separated by two rest energies, 1 for the particle and 1 for the antiparticle. If a body moves at a high relativistic speed so that the gamma factor becomes about 9, and the total energy is thus 9 times the rest mass m_o of the body, then the kinetic energy adds 8 m_o to the rest mass. There is also a gamma factor of -9 for a total energy of -9 m_o and a kinetic energy of -10 m_o. This suggests that the body's corresponding antiparticle rest mass in the negative realm of the Dirac sea has also increased by -8 m_o. This explains in simple arithmetic how the particles and antiparticles are formed and how high energy physics can produce jets with lots of particles and antiparticles scattering from relativistic particle collisions.

In my mind ignoring certain outcomes predicted by a mathematical model is illegal physics. You do not choose a mathematical model and then throw out half or even three quarters of the results predicted by your model. There must be a reasonable interpretation for these results that applies wherever the Lorentz factor is appropriate or the mathematical model is wrong. Now let's consider the possibility of superluminal time dilation and mass increase.

* $\Delta t = \Delta t' \gamma$. If $v = 2^{1/2}\ c$, we get $\Delta t_o / \Delta t = i$.
* $m = m_o \gamma$. If $v = 2^{1/2}\ c$, we get $m_o / m = i$.

It seems to an observer at rest that the superluminal space craft (or particle) has made a "90-degree" shift from ordinary space-time into hyperspace represented by the imaginary value. We have to map the possibilities into complex number space. When we watch sci-fi movies, the inertial observer's view of a craft shifting into warp drive is usually that the craft gets smaller, stars get streaky, and then the craft simply disappears from the inertial observer's vision. When the stars get streaky, that is the director confusing observer viewpoints. Streaky stars is perhaps from the viewpoint of the observer in the

craft. Reported observations and some purported videos of alien craft suggest an ability to jump from place to place or simply appear and disappear from view at will. Such maneuvers suggest the craft may be jumping in and out of imaginary hyperspace at superluminal speeds.

Einstein simply asserted without explanation the principles of relativity under uniform velocity and the constancy of light speed for all observers. This is just how it is, he proposed. Palmer has pointed out (**ReSurfacing**, p. 111) that whenever you encounter an assertion that implies "this is just how it is," such a statement usually is a cover for a transparent belief. We can do some brainstorming to uncover the core belief or beliefs that might underlie such an asserted reality.

Exercise: By yourself or with some friends ask the following question, and see what responses you can come up with. "What might someone believe in order to experience that light moves at velocity *c* for all observers?" It helps to follow the procedure outlined in **ReSurfacing**, Exercise #23, "Transparent Beliefs". When you have finished the exercise, read on below and compare your answer to what I came up with. We may agree, or we may disagree. But in any case we will have thrown some light on possible hidden assumptions behind Einstein's famous assertion.

I came up with the notion that any observer essentially must be non-local. A corollary of this belief is that light (EM radiation) never moves relative to itself – which is all there is from that viewpoint. When an observer observes an event from anywhere in the universe, he observes from the viewpoint of *c*, because that is how our organs of perception work. Although local observers differ in terms of space/time reference frames, they all share the non-local view from the viewpoint of *c*. Various local viewpoint frames cause signal delays and distortions. Einstein thus had to amend Newton's laws of mechanics to make them relativistic when the speeds involved approach that of light. Newton's laws thus became special cases for slower speeds. For example, here is what happens to Newton's second law ($F = m\,a$). We must include the Lorentz factor.

* $F_{tot} = m_o\,[d\,(v\,\gamma\,/\,dt]$.

Put simply, the shift in wavelength and the increase in mass is a distortion caused by the Earth-bound observer's viewpoint. At relativistic speeds we need to add much more force to get additional acceleration, because of the mass increase (**but only if we are operating from an "outsider" frame like the operator of a particle accelerator**). That is also why, to an outside observer an object falling into a black hole falls ever more slowly onto the event horizon and never can be seen to pass it, though it eventually seems to fade away on the event horizon. On the other hand, to a person falling into a black hole, there is acceleration through the event horizon and then a free floating condition beyond the event horizon that we will discuss more when we come to study gravity. It may be that material inside a black hole also tends to aggregate at the event horizon.

When a jet plane passes beyond the sound barrier, observers on the ground hear a sonic boom, and then the sound of the jet becomes detached from the jet (**relative to a ground-based observer at rest**) and seems to trail far behind the jet. The pilot suddenly hears the sound of his jet become very quiet, because most of the jet engine sound trails behind him. However, **he still feels the vibrations of the plane's local structure going along right with him.**

The reality is that motion is a mental illusion caused by the observer's resistance to certain experiences. Physicists often calculate the value of *c* in what they call "natural units". They simply assign the value of 1 to *c*. Thus the factors in the Velocity Equation become reciprocals: (1/n) (n/1) = 1. Light speed *c* = 1 is then really equivalent to no motion at all. All phenomena are constructed from light, and nothing ever moves (from the viewpoint of light). Consider the time dilation equation.

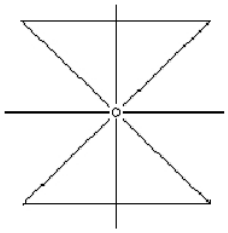
* $\Delta t = (c\, \Delta T / c)\, (1 / [1 - v^2 / c^2])^{1/2} = \Delta T\, \gamma$ **(If c is constant for all observers.)**

Thus, to the observer at rest, the moving clock stops when $v = c$, because Δt becomes infinite and indeterminate in a nonlocal frame of expanded consciousness (1/0 = ?). Light, and all EM radiation is not really radiation, but exists beyond space and time in an eternal realm of being. This is undefined awareness, and what some call enlightenment. **Different locations in space and time represent a system of storing data in the mind of an observer. Different relative frames and accelerations are forms of resistance used to evaluate and interact with experiences based on various belief systems imagined into reality by the observer.** Thus **travel** is a form of resistance to **what is**, **just as it is**. Someone wants to change things. Shifting situation A into situation B depends on the skill of managing beliefs so as to get to the belief/experience condition that is preferred. All possible conditions are acceptable to awareness, but not necessarily to an observer observing and/or participating in such conditions. The observer can manipulate his experiences by managing his beliefs in such a way that the experiences reflect the preferred beliefs. This involves use of will, and the use of will may involve developing and expediting various theories, experiments, and engineering applications.

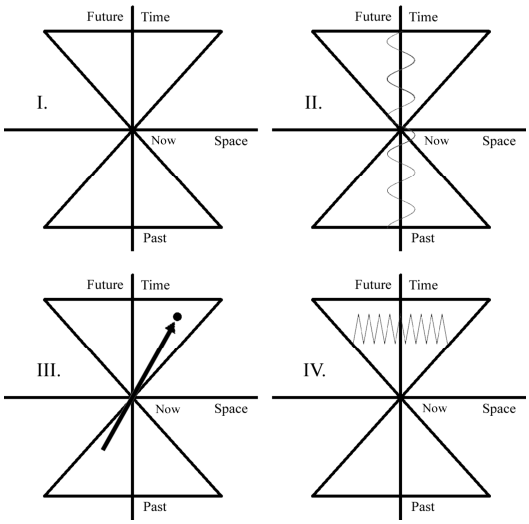
The observer may choose a local viewpoint or a non-local viewpoint. Non-locality is relative, but ranges from any viewpoint that includes more than one object of attention to a viewpoint that includes all possibilities and is completely undefined. Thus, between point-value awareness and undefined awareness there is a huge range of potential overlap between local and non-local defined viewpoints.

The Light Cone

A tool that is often presented as an aid to visualizing various kinds of motion is the light cone diagram. Below is an abstract two-dimensional light cone.

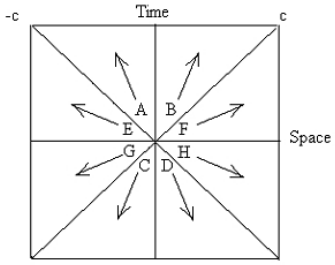


This diagram consists of an origin marked by O. Through O there is a vertical axis labeled the Time Axis and a horizontal axis labeled the Space Axis. O is the observer's position in the present moment. Upward on the Time Axis represents the future, and downward represents the past. To the right on the Space Axis is arbitrarily called the positive direction, and to the left on the Space Axis is arbitrarily called the negative direction, but both directions are equivalent displacements in space along one axis. The three supposed "dimensions" of space are collapsed into a single dimension. Also passing through O is a pair of lines at 45 degrees. These represent the velocity *c*.



Cone II shows a time-like particle oscillating in space without any net movement in space. Cone IV shows a space-like particle oscillating in time with no net movement in time. Cone III shows a time-like particle moving through space at a velocity less than *c*.

Relativistic Motion and a Generalized Light Cone



The above sketch is an abstract diagram in which we can explore the major possible generic Lorentz transformations of a single particle event from a transcendental "resting

frame" showing one dimension of space and one dimension of time. If we rotate this figure around the time axis, we get a light cone with two dimensions of space and one of time. Each arrow can represent the same event as seen by a different observer -- A, B, C, and so on, standing at her Origin center of the diagram in the present and looking out at her world and observing a particle moving "away" from her in a certain direction in space-time. The diagram in its two-dimensional representation is perfectly symmetrical.

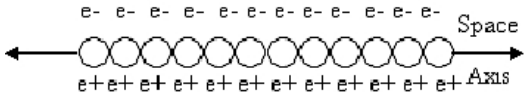
All observers at the center point origin are always at rest relative to themselves in space. They therefore seem to move straight upward at a uniform velocity along the Time Axis, but with no spatial motion. With no deviations in space, they are unable to tell time, so they at least require some pulsation (like a heartbeat) within their self-space to know the passage of time.

Observers A and B look out into space and experience a particle moving away through space in an ordinary time-like manner (less than *c*) -- spatial displacement grows as time passes. However, observer B sees the same particle from the "other side", apparently going time-like in the opposite direction in space from what A sees, or possibly it is a different particle.

Observers C and D see the same particle as an antiparticle -- that is, a particle moving through space but backwards in time in one direction or the opposite direction. Of course, relative to them the antiparticle seems to be moving in an ordinary time-like manner, but its spin (recall the top spinning on a clear glass coffee table) and charge are reversed from what A and B see, so observers C and D know that the particle is traveling in an opposite direction time-wise relative to them than the particle as observed by A and B. To a time-like observer the cause-effect sequence seems to be maintained, but actually it is reversed in the case of the antiparticles.

Observers E and F both are unable to see their respective space-like particles, nor can G and H see their space-like particles, because they are moving through space faster than light-speed *c* and have moved out of these observers' detection range via EM observation in the light cone. Only observer I, which is you, the observer, transcendentally facing the square diagram, can see the non-local space-like particles, because you are positioned orthogonal to the plane of space-time and can see the whole Space Axis in one glance. When you see a line on a piece of paper, you are seeing a space-like dot from your privileged I-observer viewpoint, so this is not really anything that remarkable. A purely space-like particle looks like an ensemble of identical time-like particles relatively at rest in some sort of array. This array is formed by the path of a quantum field bubble chain that is carrying information from A, B, C, or D's light cone into another cone instantly. It is like an infinite space-like superluminal phase wave in a wave guide. If you look closely at a quantum "particle event" passing down the space axis of the F-H "anti" light cone, you "see" it zigzagging back and forth in time just as time-like particles at "rest" jiggle back and forth in space. "It" showers across space as a chain of virtual particle-antiparticle pairs fluctuating invisibly in the Planck scale of the pure vacuum state. The "shower" can occur in a single moment everywhere in the universe. This is the quantum foam, exemplified in the diagram below with only a single space-like virtual quantum fluctuation of electron-positron pair production and annihilation. Given

various local conditions some, many, or all of the virtual particles may move onto the time line and appear to "stabilize" in time. The same diagram rotated 90 degrees shows the electron-positron virtual fluctuations occurring continuously along the Time Axis at a single location in space.



Instantaneous Space-like Electron-Positron Pair Production throughout All Space.
(The line of quantum fluctuation becomes a volume for 3 dimensional space.)

Space-time

In space-time events in space are inextricably bound up with time because of the finite speed of light. We can think of time as space by simply multiplying a velocity times the time elapsed during the velocity ($v\Delta t = d$), where d is displacement, Δt is a time interval, and v is a velocity. When we start to look at the big picture of the cosmos, the time lag due to light speed that we can usually overlook on our local planet becomes a significant issue. We have to reinterpret time on our Space-Time Diagram by putting it in terms of light speed: $c\Delta t$, or just ct for short. Following the suggestions of Poincaré and Einstein we say that the laws of physics stay unchanged under Lorentz transformations (Lorentz first derived them):

* $x' = (x - vt)\,\gamma,$
* $y' = y,$
* $z' = z,$
* $t' = (t - vx/c^2)\,\gamma,$

where velocity v is uniform motion along the x-axis and also fills the role of v in γ. From the viewpoint of the moving observer, the observer at rest seems to be moving, so we just switch the primes from the left side of the equation to the right side. The general form in which both sides of the equation look the same after a transformation is:

* $c^2t'^2 - x'^2 - y'^2 - z'^2 = c^2t^2 - x^2 - y^2 - z^2.$

We can remove the c's by using natural units, c = 1. We also can put all dimensions at the scale of light speed, using 3×10^8 meters as our unit of spatial displacement. Note how all dimensions, including time, are inherently bidirectional (have positive and negative roots) by virtue of the "squaring". (We will discuss the so-called "arrow of time" in chapter 12.) **Remember that this "space-time" model is based on a totally arbitrary assignment of 3 "dimensions" to fundamentally isotropic space.**

* $t'^2 - x'^2 - y'^2 - z'^2 = t^2 - x^2 - y^2 - z^2.$

In this abbreviated notation energy and momentum look like this:

* $E = m = m_o\,(1 - v^2)^{-1/2}$
* $\mathbf{p} = m\mathbf{v} = m_o\mathbf{v}\,(1 - v^2)^{-1/2}$

* $E^2 - p^2 = m_o^2$; and the transformations become:
* $p'_x = (p_x - vE)\,(1 - v^2)^{-1/2}$,
* $p'_y = p_y$,
* $p'_z = p_z$,
* $E' = (E - vp_x)(1 - v^2)^{-1/2}$.

Going back to our light cone, we find that we can "look" back into the past many light years that are in our light cone, and we can look into the future many light years that are in our cone. As an observer, the act of observation links the observer causally with what he observes, whether in the past, present, or future. Oddly, when we look far away in space, we look farther back into our past, because we see events unfold that have taken a certain time period to reach us via light transmission. Thus with attention we look into the future from the future's past by peering far out into physical space and we look into the past from the past's future by peering far into the mental space of memory. We can change our perception of both past and future by adjusting our viewpoint in the present.

What about Space Axis observation? Yes we can observe in the spatial zone of the light diagram and along the Space Axis. What we see is not motion, but **multiplicity**. We see the whole diverse environment of our present moment stretching out along the Space Axis as multiple copies of basic forms in various combinations. They coexist simultaneously, and we can see them by observing from a viewpoint orthogonal to the spatial "plane", the same way we look at an orchard from a hot air balloon and see orderly repetitions of the same tree filling space or at a crystal with orderly repetitions of the same molecule.

A special case is that of the photon moving in free space. It has zero rest mass. The photon has energy and momentum, but no rest mass, since its energy is in its **frequency**. Its momentum is Planck's constant divided by the photon's wavelength. The frequency times the wavelength is the phase velocity in free space, which is c. This means that the energy and momentum of a photon are equal when $c = 1$, and the momentum of any particle is $p = vE$, that is, $mv = vmc^2/c^2$ in full notation. The photon never stops, but since all perception is via photons, **it never moves**! As Feynman points out (**Lecture**s I-17-8) , if we use the formula $m_o\,(1 - v^2)^{-1/2}$, the mass is zero, and $v = c = 1$, so it all cancels to zero, which means the energy is zero. And that is the truth!! But Feynman reminds us, "this [energy] it possesses by perpetually going at the speed of light!" Of course, he does not remind us that the solution to the paradox is that the notion of light speed is only a relative perception for an observer who believes that he is **NOT** going at the speed of light. From the standpoint of light, the observer is always at rest in an inertial frame with photons. In our expanded brave new world perspective space and time are inextricably bound into a single wholeness. After all, they are beliefs in our awareness that we use to separate "things" that we resist unifying and have no physical reality beyond that.

Newton's Assumption and Photons

Newton made a transparent assumption with regard to gravity. When he stated his law of gravity, he assumed that any two massive bodies interact gravitationally from a

distance with no lag time between them.

* $F = G\ (m_1\ m_2)\ /\ r^2$.

This law implies that the force transmits instantaneously between the two masses, regardless of the distance between them. Newton did not even know about the finite speed of light much less the possible finite speed of gravity, so his laws of mechanics only work in special local cases. Physicists feel that Newton's gravitation law must be adjusted to match Einstein's general relativity adjustment of $F = m\ a$, since the gravitation law is also a force law and it tends to be useful mostly on a celestial scale. The problem is that no one has directly observed "gravity waves", much less timed their velocity of propagation. We just see the results in the motions of bodies. However, measurements were made in 2002 of a quasar's conjunction with Jupiter to see if gravity waves could be detected. First reports claim gravity moves at light speed.

The study of binary pulsars by Taylor and Hulse also seems to confirm that gravity waves must move at light speed, because the data fit Einstein's predictions when Einstein's equations are assumed. They did not know the total masses of the binary objects, so to get that and then the individual masses they had to use the Doppler and periastron shifts and run the equations backwards using Einstein's equations. Once they had what they believed to be the masses, they still had to watch the data for a long time to see if there was the orbital decay due to energy loss from gravity waves in the pattern predicted by Einstein. The net loss of energy leads to reduction of period and shrinking of orbit. They could not detect the gravity waves, since they are far too weak to detect from that far away (if they exist). All they could do was detect the tiny reduction of orbital period over a number of years and compare it with what Einstein predicted along with the belief that gravity waves move at *c*. Thus, the evidence is suggestive since it fits Einstein's curve, but is still indirect evidence derived from indirect evidence and a bunch of assumptions. The data fits Einstein's equations, but does not necessarily mean Einstein's theory is correct. Maybe they got their data to fit Einstein's equations because they used Einstein's equations to calculate. There could be other factors at work that produce the observed "results". Lorentz arbitrarily produced his "contraction" formula to show "mathematically" how Michelson and Morley could not detect changes in light speed due to Earth's relative motion in the aether. Einstein expanded that idea to a more complete theory that "justified" the **arbitrary** formula of Lorentz. Nevertheless, the results of Hulse and Taylor are impressive, and anyone criticizing the results has to come up with a better hypothesis to fit the data. So Observer Physics tentatively accepts the notion that gravity's influence travels at *c*. This makes sense from the viewpoint that gravity is a special form of EM interaction mediated by special photons called gravitons by physicists in the Standard Model theory. The electro-gravity equilibrium relation also suggests the two types of force may transmit at the same speed, but at different scales.

On the other hand, if we look for a transparent belief behind Newton's law of gravity, we might surmise that Newton subconsciously believed that gravity is a holistic, non-local phenomenon. It arises simultaneously everywhere from the vacuum state reflecting the mass/energy condition of space/time. In Observer Physics we will propose a solution to

the question that is part way between Newton and Einstein and satisfies both. (We develop a possible solution to this issue later on in this chapter. Our more complete theory of quantum gravity unfolds in Chapter 14.)

Photon Pairs and the Three Hairs

The whole system of photon pairs exchanging between electron pairs functions like a hyperbolic satellite system. Instead of forming overlapping ellipses, the fermion electron pair forms separated hyperbolic wings. The two periastrons of the hyperbolic trajectories form the vertexes of the interaction. The photon pair exchanges between these two periastrons. The center of mass of the system is somewhere at the middle of the photon's path between the electrons. The electron hyperbola wings are asymptotic, squeezed between the subluminal edges of the light cone. The photon exchange is like a stream of sand passing through the center of an hourglass from future through now into the past, and the observer looks upward from below at the stream of sand, and that is his experience in the form of consciousness. Ouch! Bad simile, here's sand in your eye.

The electrons are like the B_u's, and the photon path describes the equivalent of the semi-major axis. It is a fractal echo, again in conic sections, of the structure of a single electron and of the macroscopic solar system. The photon transmits energy (resistance) at maximum speed in a linear fashion. The electron spins and anchors resistance at a slower speed, but with greater inertia. Free electrons have no apastrons (from the viewpoint of this analysis), because their trajectory is an open curve. For electrons in orbit around a nucleus, the periastron is the radius of the ground state after photons are emitted and the apastron is the radius of the excited state when photons are absorbed.

All phenomena are basically built from the "three hairs". These hairs are mass, charge, and spin. All other properties (such as quark flavors, magnetic moment, and so on) are derivations from these three hairs. The three properties are all woven together. They can not be isolated. All particles are created by whirlpools of photonic energy circulating around tiny centers that are like black holes. These are eddies of energy created by resistance. Resistance comes from concentration of attention. Energy is concentrated attention. Attention is the flow of awareness through a viewpoint. It moves in the form of physical-mental conjugate photon wave functions. Attention "particles" are advanced photons. But we have seen that advanced and retarded photons are relative to viewpoint. In phase conjugation if [W] is a retarded photon wave and [W]* is its advanced photon wave, we can just as easily turn the tables and define [W] as the advanced photon and [W]* as the retarded photon. The object you observe is defined by you and projected into mental and physical space from your undefined awareness.

Exercise: Look into somebody's eyes and allow your attentions to conjugate. Who is looking at whom?

Photons are attention particles. When I look at someone, I send my advanced photons to her and receive her retarded photons. When she looks at me, she sends advanced photons and receives my retarded photons. We like to call our own photons advanced, I

suppose, because of the egotistic illusion that we are advanced and others are retarded. (joke) But, as we have seen, the group velocity and phase velocity aspects of photons are entirely relative to viewpoint -- and arbitrarily selected and defined by the observer. My advanced photons may be retarded to another person, and vice versa.

Einstein showed in his study of the photo-electric effect (stimulating emission of electrons by light) that the intensity of photons comes from the number of photons, but does not affect their individual energies as particles. The energy of photons resides in the wavelength (frequency), and that energy threshold determines when electrons are stimulated into emission from an illuminated substance. By his analysis he showed that light has a **particle nature** as photons.

Focus of attention brings greater clarity of vision because there are more receptor cells in the central region of the retina and fewer cells in the peripheral areas. This same is true for the other senses. The evolution of more receptor cells in the central region of a sense organ derives from greater attention being placed on focused than unfocused attention. The higher resolution of focused attention acts as a magnifying glass on objects on which attention is focused. If we habitually began to defocus attention, we eventually would rearrange the distribution of receptors in our sense organs.

Experiment: Have a partner gently touch the pads on your finger-tips with a pair of pins. Have your partner start with the pins about three quarters of an inch apart and gradually move them closer together. Keep your eyes closed and feel whether he touches you with one pin or two. How close can they be before you can no longer distinguish whether one or two pins are touching you? Try the same procedure somewhere on your forearm or your back. How far apart are they when you lose the ability to resolve individual points of contact?

Exercise: Select an object and focus attention on it for a few minutes. Do you notice that the object of your attention's focus seems to become not only clearer and more brightly colored, but also larger? (See **Resurfacing**, Exercise #3.)

Really strong energy concentration reaches black hole energy densities and bends the space/time in the area of focus so that the advanced photons begin to circulate as eddies of space/time. This manifests the photons as subatomic particles of matter. Relative to the photon, the energy is still in the linear momentum and is moving forward in a straight line resultant (in free space). Relative to an observer outside the event horizon geodesic in which the photon runs, the energy is now localized as a little blob. Like an eddy in a stream that forms by a rock and then detaches and floats around, the blob can take on a life of its own, moving at group velocities. It is also observable!! But only indirectly. You can not observe a photon from the "side", and you can not see any particles. You can only see photons, and they must be experienced "head on" when they exchange energy with your "particles" of resistance. They interact with your current viewpoint and say, "Hey, I am here." Then you can infer their existence.

Bang your hand against a brick. Do you feel a sensation? Just look at the brick. You

can see it, but there is no sense of touch other than the impinging of photons on your eye. How much mass does the brick have? The only way to measure the brick's mass is to push the brick in some way – with your hand or with your eye. Is the brick resisting your push, or are you resisting the brick? Who started the interaction? We only sense mass when we interact physically with an object. How much mass a brick seems to have depends on how intensely we push against it. Even light energy has a momentum component that can give a tiny push though it has no rest mass. So just looking at a brick causes the brick to push slightly on your eye by means of the light that it reflects into your eye. You push on the brick with your attention in order to get an experience of it.

What Makes it Solid?

From this little experiment we realize that the way to create a brick that has mass involves several operations.

Operation one: You design a brick with a certain shape, size, and material structure.
Operation two: You separate yourself from the brick so it seems to be an object.
Operation three: You create a belief that the brick is harder than your body and put a lot of conviction behind that belief.
Operation four: You resist the brick in some way that demonstrates and thereby "proves" that you are weaker than the brick.

The solidity of objects depends on someone's subjective resistance to them and is not an inherent quality of the objects. Atoms and molecules are made from empty space with massless photons flowing around in it. Photons and space inherently have no mass. The closest we can come to an objective sense of mass arises from the repulsion of like charges that are pushed against each other. The brick is held together by electric charges, and our hands are held together by electric charges. Therefore the unit of mass should be determined by the elementary quantum of electric charge in terms of the behavior of the elementary charged particle – i.e., the electron. This gives us a universal objective value for mass. What that feels like is entirely the subjective decision of the observer as a participant in his universe. The problem is that mass in any conventional sense is unobservable to a totally objective observer. However, we still have to account for how interacting charged bodies generate the stress of forces acting on masses.

We can observe interactions taking place, but at some point we must get into the situation and push something in order to establish a standard for mass. The same is also true for time and space. Without first establishing an observer viewpoint within a contextual environment with some base landmarks and interactions we can not establish where we are or what time it is.

Some people practice "martial arts" and work back through the solidification process to unlearn the core (and usually transparent) belief that they are weaker than the brick and the belief that the brick is harder than the human body. Then they demonstrate that they have successfully unlearned such beliefs by breaking bricks with their bare hands to the amazement of those who have not unlearned such beliefs. I have not tested this

procedure on bricks, but have worked it through on pine boards. Not only can the bare hand break pine boards, it can do so with casual effortlessness once the mind discards the belief in the hardness of the board relative to the hand. (Do not try that experiment without some expert guidance to get you started or you may hurt your hand. That is a no-joke joke.)

All perceptions are via photon exchanges, even perceptions of pain. Strange as it may seem, we only infer the existence of other particles indirectly from photon exchanges. The whole thing may be just in our imagination. To see a photon, you have to absorb it, thereby "annihilating" it and absorbing its energy. In a sense, experiencing an object destroys it. Another way to indirectly observe a photon is to allow Compton scattering to take place and to note the shift in the trajectory of the scattered electron or other particle that the photon interacts with. You can observe an electron -- but only indirectly via "head on" photons. This is not just because of the small size of the electron and its fast speed, but because it is "transparent". A photon just energizes it and generates a vertex in its trajectory. At least you can observe its track as it moves through a bubble chamber or some such device. But photons (and neutrinos) just zip right through the chamber. You only know of them through the scattering patterns of photons or observable particles interacting with devices that eventually transfer the energy to your attention via photons.

From our fundamental principle of light overwriting itself by appearing to curl around to form a black hole whirlpool, we immediately gather some important conclusions about the quantum nature of spin that makes it quite different from classical spin on the macroscopic scale. We know that the fermion particle is made from at least one photon vibrating in a closed circle. This means that its speed of whirling must be *c* (at least at its "event horizon"). All subatomic particles spin at the same speed regardless of their energy and/or mass and that is *c*!!! This also means that the spin, and also the electrical and magnetic effects of subatomic particles and their ensembles that have charge, will come in discrete quantum units of charge. From our theory of advanced and retarded photons, we realize that neutrinos, electrons, and protons, are made of attention particles (i.e., "anti" photons). A portion of someone's consciousness is locked up in these tiny black holes. Actually, we should say that a CONJUGATE REFLECTION of a particle of consciousness is locked in the black holes of particles.

The spin of subatomic particles has very special quantum mechanical properties that are not found in macroscopic spinning objects. Quantum spin is associated with quantum magnetic moment. The particle behaves like a tiny little magnet with poles. This can be seen in the Stern-Gerlach experiment where electrons can be separated into two types, spin up and spin down. This up and down relative spin orientation helps structure the patterns electrons take as they build orbits around nucleons. They tend to form into up and down pairs balancing the magnetic charge. Although the electron is a fermion, it remembers that ultimately it is a boson photon. So it craves boson experience. It gets closest to that by forming Cooper pairs -- a spin up electron and a spin down electron matched together. In superconducting materials, the super-cooled materials become so orderly that the electrons pair up neatly into Cooper pairs and the substance takes on

boson behavior, forming a macroscopic quantum mechanical system.

The various classes of particles are found to have quantum spin values. Boson particles have integer values, and fermions have half integer values. Fermions lack wholeness, because they represent an unfinished event. An event is a handshake between belief and experience, attention and perception. The photons inherently form nice pairs. They are more complete. The mesons echo this "wholeness" by forming particle-antiparticle quark pairs at higher energy resonances than ordinary photons. They are just super-powerful photon eddies. But they are unstable and decay rapidly, the longest mean life being on the order of 10^{-8} seconds. An electron must have a partner electron with which to balance its spin magnetic moment and to exchange photons. Otherwise, it can find an antielectron (positron) and they annihilate back into photons. Fortunately, most positrons are buffered by quarks inside protons so they do not spontaneously bump into electrons and annihilate.

Here is a chart of the various theoretical and observed quantum isospin classifications, referred to as (Jp) value.

Spin-0:	Higgses, sleptons, squarks, mesons
Spin-1/2	leptons, quarks, gauginos, Higgsinos
Spin-1	gauge bosons (force fields)
Spin-3/2	gravitino, (omega minus baryon)
Spin-2	graviton

Of these various entities only **mesons, leptons, quarks**, and **gauge bosons** have been observed. And quarks are confined inside baryons and mesons. Higgses, sleptons, squarks, gauginos, Higgsinos, gravitinos, and gravitons are all theoretical particles proposed in various unified field theories. The motivation for the graviton is the requirement that there be a force field energy exchange vehicle for gravity. Higgses are proposed to explain how it is that the heavy bosons are found experimentally to have mass when the invariant gauge theories inherently do not generate particles with mass. So Higgses are thought of as a bridge between energy and mass. The field equations have to jump through a lot of hoops to get intermediate vector bosons with mass. Sleptons, squarks, gauginos, Higgsinos, and gravitino are all brought up as heavy particles needed for grand unification and super-gravity theories.

The squarks mentioned here are different from the squarks I discussed earlier. Those particles have a spin 1/2 when viewed as matter. My squark resembles a big orca swimming just below the zero point surface of the vacuum. The observed particle is his dorsal fin. Wherever matter appears, there is a slight general disturbance in the vacuum state in its vicinity. This covers quite a region of space. We can call it a squark. But we will have clearer models of the whole setup as we probe deeper into the internal structure of the proton.

Observer Physics has no problem with predictions of heavy particles that have not been seen. Heavy particles certainly exist at high-energy concentrations. They occur

naturally as the higher resonances of the proton model. We have already identified several heavy particles. The B_u's are in the range of 10^{-9} kg. The Q-particles (squarks) interpreted as ordinary masses are really heavy, the Q_{ne} (corresponding to an electron neutrino) possibly reaching the mass of a Jupiter sized planet. But such particles can not exist in the same way as protons in our current universe. The average energy density in our observer space is too low to sustain them above the zero point, so they decay right away back into the vacuum state. But they exist everywhere all the time in the vacuum state as virtual particles and tend to hover underneath manifest particles like the orca under his dorsal fin. The vacuum state is constantly boiling such particles into virtual existence, and then annihilating them, as we shall see when we diagram some of the adventures of particles.

Think of an orca (or even just a wave on the ocean). Ordinarily, when you see an orca or dolphin swimming along near the surface, you see a dorsal fin moving along cutting through the water's surface. The orca is very large, but you just see the fin. (You only see the crest of a wave, not the big part that runs under the surface.) If the orca gets excited, he jumps into the air and you can see the whole animal. In a storm the waves can kick up high. Neutrinos, electrons, and protons are like this. The whole big animal is running just below the surface of the vacuum. A form of symmetry breaking (due to our habitual rarefied energy density viewpoint) that puts lighter particles on one side of the vacuum zero point and heavier ones on the other holds them there. What you can detect in our ordinary space is just a tiny particle zipping along. It is just the dorsal fin of a much larger animal. By staying under the surface, the heavy particles can be more relaxed and unfocused.

If the photon corresponds to the attention, then the graviton corresponds to the will. The will generates desire and resistance. Will has created particles with mass and set them in motion. The attractive power of gravity comes from matter's remembrance that beneath its fermion behavior of Pauli exclusion lies the boson behavior of comfortable coexistence in one place -- quantum condensation, phase conjugation, and coherence. Matter is made from light. It remembers being light. The best it can do in its stressed form is to try to draw as close together as it can. But light also appears to travel fast with momentum in our distorted perspective. This gives fermions a contradictory tendency toward inertial momentum. The resolution of the contradictions is equilibrium – "established in yoga, perform action," as the ancient **Bhagavad-gita** says.

Just as the photon is the retarded wave packet companion for the conjugate advanced wave packet of attention (focused awareness), the graviton particle is the retarded wave packet companion for the conjugate advanced wave packet of the focused will. Palmer speaks of aware will, and the Maharishi speaks of creative intelligence when describing a cosmology of consciousness. Intelligence is awareness, and creativity is will. (These are labels we will use. Other labels are possible.)

Why are we attracted by the gravitational influence of the planet Earth? This attraction is the conjugate mirror reflection of our love of and desire for this type of environment. It is the result of our **deliberate, willful, decision to be here**.

By love I do not necessarily mean mushy romantic love, although that also has its role. I mean simply the "attractive force" generated by deliberately placing attention on something. The more attention put there, the more concentrated the wavelength, the more solid the environment. As the Maharishi says, "What you put your attention on grows in your life." Gravity is the conjugate reflection of that. We love our bodies and the earth so much that it hugs our bodies and attention tightly to it as an experiential reflection of and fulfillment of that desire. Resistance to gravity on our part is resistance to a primordial longing to play in a material world, which is itself a resistance.

However, we can recall that this resistance is nothing more than a habit of attention. As we enter a new age, our will can direct our attention in other directions. We may desire to leave our gravitational field and explore zero-*G* space and other planets. Gravity becomes a secondary problem left over from our previous intention that holds us from our new primary intention. As we reorient our perspective regarding gravity, the *G* force will shift in intensity. It is possible to assume viewpoints in which you become weightless even within a gravitational field. Try it as an exercise. It is not very difficult. David Copperfield (the illusionist) has an awesome demonstration where he floats and soars about the stage totally independent of gravity with grace and beauty as if flying in a dream. I have no idea how he does it, but it sure is an eye opener. You do not need to put on a show or be acrobatic, but you can defy gravity easily and effortlessly yourself.

Experiment: Discover how to make yourself weightless. Hint: Remember what we have said about the relationship between mass and resistance. Also, do not get stuck in habitual viewpoints. Caution: Don't walk off a cliff or tall building unless you are successfully able to lift off and hover from the ground and have full confidence in what you are doing. Start exploring in your room. Once you have truly mastered the art, then you are on your own responsibility. If you feel you need coaching, the Maharishi has a course where he teaches you the basics of how to do "yogic flying". How much do you weigh when you are asleep? How much when you completely relax?

Gravity and will form a conjugate pair. Exercise of will initiates kinetic activity, the manifest form of gravity's conjugate. The graviton mediates the gravity interaction. Gravitationally interacting objects have mass, but the graviton itself has no mass. Physicists assume that it moves at *c*, the speed of light, so it must be without mass. But there is no reason why it should be subject to *c* velocity. The collapse of the wave function has been shown by Bell's theorem and Aspect's experiments to be virtually instantaneous and non-local. This suggests that the graviton may also be non-local and instantaneous in its transmission. It operates from the level of undefined awareness. The will is the feature of undefined awareness that allows for the creation of definitions. The will arises directly from undefined awareness to define creations. It is not located any "where". That means gravity may also arise globally in the same way. The "evidence" given by Hulse and Taylor supporting velocity *c* for "gravity waves" may just be the radio wave data that they indirectly measured traveling to Earth from the binary pulsar they studied. The non-local reality of the gravitational events may exist

simultaneously. The problem we face is that we can only know data via EM interactions. To establish their theory they have to observe an event like a nova and show that the light from the explosion arrives at the same time as the gravitational shock wave. The problem is that if the gravity wave arrives sooner, they will miss it, unless it is very noticeable. They may not see the light signal until several or many years later. A major gravitational event on our sun might only have an 8-minute delay, but we might not be here when the light signal arrived.

One of the undefined possibilities in awareness is the possibility of making definitions -- any kind of definitions. We call that feature "will." If gravity is the conjugate wave form of will, and you don't have any definitions in place, then there is no force of gravity. One unitary creation alone does not exhibit gravity. Creations attract creations. The more densely you create, the stronger the attractions. The fundamental principle is that undefined awareness is an undifferentiated unity. Gravity requires the illusion of diversity, which requires the putting of attention on the effort to break up primordial unity by means of definition. If attention goes to local phenomena, it loses focus on maintaining the fiction of breaking unity into diversity. The diversity then tends to flow back into unity by default. Thus, as we play with attention in our local identities, our global attention to resist unity wanes and diverse creations tend to clump together in their return to unity despite the momentum of a push to separate them. Gravity is therefore very much concerned with a property we call density -- the distribution of creations within a given space. But we must reserve exploring that topic more deeply for our discussion of thermodynamics and gravity later on.

For now we recognize the existence of gravitons, not as a particle with a force of attraction, but as a particle that pushes creations apart. That means we must get to the fundamental nature of resistance in order to understand gravity (and charge). For now we can say **gravity is the manifestation of the retarded graviton wave which is a relaxation of resistance**, and **will is the manifestation of the advanced graviton wave which is the assertion of resistance**. The graviton itself is massless and propagates at a velocity that is either infinite (a holistic impulse) or much faster than *c*, although information about gravitational events travels at *c* via photons. I favor the second choice, because the graviton is a defined creation with both mental and physical aspects. It therefore can not be infinite -- no defined phenomenon is infinite. However, we can't measure its speed unless we can observe it. And we may not ever observe it except from the non-local level at which speed is not very relevant by definition.

I suspect that the graviton has spin 0, (whereas most physicists imagine that it has spin 2); but that's just my intuition based on the notion that wholeness doesn't spin, because it has nothing relative to which it can spin. Also, if the graviton travels at *c* in free space then it will be linked to *c* and will propagate entangled with photons. Graviton particles may be generated only at the level of the entire universe, which can not be spinning relative to itself or any frame. That hypothesis suggests the scale from which the indomitable will arises.

The will arises from a different level than the attention. Will is innately non-local, and

attention is innately local. Thus attention particles and photons move at conjugate versions of *c*, whereas will and graviton particles move at conjugate versions of a much faster superluminal propagation velocity.

We can add some support to that hypothesis by looking at the nature of observer viewpoints. Imagine you are a viewpoint in unbounded space. You sense in all directions, but there is nothing elsewhere. There is just a point resonating in an infinite space of potential. This is an observer existing alone with nothing to observe. You can't even tell the difference between your point value viewpoint and the undefined space in which you exist.

The Big Lie

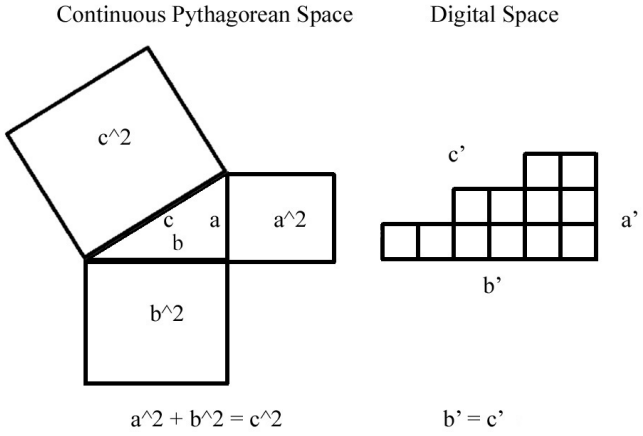
From an observer's point of view I must first create a viewpoint that something exists that is **not me** if I want something to explore other than myself. Why? "Me" is lonely and boring, which is also why most people really are **not** interested in the unity of enlightenment despite what philosophers and gurus advertise. I make it "not-me" by believing that it is separate from me. This is the "big lie" and simultaneously creates a "me" identity that is ironically defined by the way I define the "not-me". This is the fundamental principle of reflection. People get thoroughly into the belief that the world is not-me without realizing that the world is exactly how "I" define "me". I (pretend I) am not the rest of the world, so the world is a perfect reflection of what I am. What's more, I created it that way. Uh oh! Who has been playing the game of ducking responsibility!

I can get involved in my world by jumping into the not-me and pretending that me is now in the not-me. The difference between not having a not-me and having a not-me, and the difference between being completely separate from not-me and jumping into not-me generate the notion of time. Things start to change.

Creating a not-me is a resistance to being just as I am. This is the first generation resistance. It is cosmic impedance, and it creates the illusion of **gravity**. It also creates the seed of space which is two viewpoints -- transcendental me and defined not-me. Note that right off the bat space is quantized. Getting into the not-me and defining a viewpoint within it that is not all of it generates the notion of space within the not-me and also generates the notion of relativity. There is an uncertain space there between the two points of not-me and me-within-not-me that mathematicians sometimes call a **neighborhood**. We can fill this undefined neighborhood with all sorts of interesting creations. Space is made of viewpoints and neighborhoods. We can define viewpoints, but neighborhoods remain uncertain unless we also define them. If we define our neighborhoods with a metric, then we live in digital space and the geometry seems very different from continuous Euclidean space. For example, in continuous Euclidean space the Pythagorean relation holds for all right triangles.

On the left side of the sketch that follows, if a = 3 units and b = 4 units, then $c = (a^2 + b^2)^{1/2} = 5$ units. On the other hand, if we work in digital space, the theorem of Pythagoras does not hold. In the example on the right a' = 3 units and b' = 6 units. According to Pythagoras c' should be about 6.7 units, but the digital space comes to

exactly 6 units. These units have the jaggies but give the same result whether a' is 1, 2, 3, 4 . . . up to a' = b' after which c' becomes equal to a'. So we need some way to distinguish all the similar paths. We can also make another formula that counts the zigs and zags. Then we get 9 as our answer and yet another formula for the relations among the three "sides" of the figure: (c' = a' + b'). Which is correct? They are all correct answers and depend on the viewpoint you take. If you make the digital squares smaller and smaller, your answer will get closer and closer to the answer that Pythagoras came up with, once you convert from your microscopic units to macroscopic units and run a diagonal through the jaggies -- unless some other weird stuff starts to happen when you get down into the microscopic scale . . . . which is what happens in quantum mechanics. Observing at a small scale involves more energy than at a large scale. You reach a scale at which the energy involved gets way out of hand and can be as big as all the energy in the universe. Long before that point things have gotten so far away from the way they work at our mundane scale that you are as if in another world.



Gravity springs from the primordial beginning of things. The reason gravity happens is that the resistance involved in separating the insistence on a difference between what we say is not-me and just being me gives the point in the not-me an interesting quality we can call mass. At first it is just the tiny neutrino mass and seems pretty harmless. But by itself a neutrino is also nearly useless, because I can not see or do anything with non-interactive neutrinos alone. I need something heftier to work with.

Light is awareness defined as not-me. Mass is light reflected through my resistance to just being me. The first "force" that appears due to this is what we call gravity. Gravity acts between any two particles with mass and is nothing more than the guilty memory that the two particles are really one but we are pretending that they are two. Because of this inherent "guilt" everything we create tends to want to glom back together again. The only reason it does not glom back together is the kinetic momentum of our prior decisions and actions. Kinesis is anti-gravity and gravity is anti-kinesis, or relaxation. Now you know why rockets work for boosting payloads into space. As you lie down and go to sleep tonight, be aware of the relaxation of gravity that draws you back into unity with Earth and the Cosmos.

The second force to appear is the electric force. Let's see where that comes from. Gravity condenses as a beam between two particles and holds them together in a unity, no matter what we do to make them appear separate in space. Electricity derives from the effort to **perceive something** in the not-me. The effort eventually pays off, because we can perceive things, but it exacts quite a price. It is also one that you get addicted to as you realize each month when you pay your utility bills. Electricity is a decision to swerve. You shift in a 90-degree direction relative to gravity's beam in order to get a better perspective on the not-me. The swerving business is very frustrating, because it initially produces no results except to radically increase the resistance level by many orders of magnitude. The real reason for failure is that the not-me is just me playing games, so I have to make a mirror somehow that will reflect whatever faces I pull. The basic concept of a mirror is a reflective plane arrayed at 90 degrees relative to my line of observation. I have to begin setting up four-wave mixing phase conjugation. I need at least one particle to act as a nonlinear reflecting surface. However, I am still in line-land on my gravity beam, just making a lot of effort twisting about. This twisting of awareness in an attempt to experience something from our pretense is the origin of quantum spin, and the spinning of quantum particles, atoms, tops, planets, and galaxies is a macroscopic leftover.

A third 90-degree shift of perspective adds even more resistance in the form of a magnetic interaction derived from the motion of the first twist, and then it is possible to see something at last with the combination of these twists and turns. The magnetic twist exactly mimics the electric twist but in the third dimension so that photons begin to appear to have transverse waves. Thus the magnetic twist is a proportional echo of the electric twist. It gives us three dimensions of space and relativity. It seems strange that magnetism should be involved with relativity, because the magnetic effect depends on the motion of electrons that need not be all that fast. The “drift” (Drude) electrons that form the current in a wire do not travel very fast, at an average of about 0.0001 m/s, which means v^2/c^2 comes to about 10^{-25}. Although the magnetic force is only that tiny fraction of the electric force, the electric force in the positive and negative electric forces are almost completely balanced out, so that the relative effect of the magnetic force dominates. (See **The Feynman Lectures on Physics**, II-1-5, “What are the Fields?”)

The first twist is the two-for-one twist that sets up the original reflection scheme of phase conjugation after the playful decision, "Let there be a point of light (awareness) that I pretend is not-me." The 180-degree phase conjugation of a virtual ray of light is no good for seeing anything, but at least it results in the potential of c^2 and the potential of interaction. I now have c and c^* (c in the opposite direction) interacting. I have a potential mirror to see myself in. However, I need a context of space and time in order for an interaction to become meaningful. And I need a body. Gravity is the observer and his willed-to-be universe in a perfect conjugate relationship. Gravity is the reflection of an observer taking seriously his resistance to not-me so that not-me seems to have a separate existence from me when the reality is that they are one and the same. If I relax my resistance into unity, the virtual gravity beam melts away immediately, returns to its unified state, and gravity instantly disappears. Do you experience gravity when you are asleep? Do you experience it when you completely relax? Do you ever

completely relax? Try it some time and see what happens. Observe closely what happens to you when you "fall" into deep sleep -- not from the viewpoint of others, but from your own viewpoint. This is an experiment you may do every day. Pay attention to it.

The line of light is a flat loop made by rapidly jiggling the observer viewpoint back and forth between me and the pretended not-me. This evolves into transmission of information between a sender and a receiver -- two conjugate aspects of the non-local Self. By pretending to cut the link between observer and observed, I twist 90 degrees at the speed of light, which is only an imaginary pretend motion, not a real one. This seems to curl the line of light into a tight circle. To do the twist and still have the possibility of seeing the light requires keeping the observer half of the conjugate pair, but pretending that the observed half is not-me. So the line splits and one half seems to form a circle while the other half watches from a circle that seems to be on the outside or in the center. The circle appears to spin because I as the observer keep rotating in order to see the show, but, frustratingly, I still can not see it. Charge arises from this illusion of spin that I create with photons -- attention intentions full of resistance to simply being. The not-me viewpoint appears to spin with a fixed quantum spin because the anti-photon of the observer attention goes around the point that it views. Once real observation is possible it appears that a point particle (electron) emits a photon that spirals out from the point particle's singularity. The spiral appearance comes from the distortion of "Euclidean" space due to the focused concentration of mass-energy (i.e. attention) in a tiny point-value space.

With the magnetic rotation (precession) added you now have three dimensions of space in which to move about in and observe. You are a positron, and what you observe is a photon emitted by an electron. However electrons and positrons attract each other with both the gravitational and the electric force, so they spiral together and annihilate each other. Each time a viewpoint gets started, it pops back out of existence and back into undefined awareness as raw photon pairs, which is very frustrating for our Great Pretender. They unite and annihilate because their essential nature is balanced unity. Mechanically speaking, the particles spit out photons and the antiparticles ogle out anti-photons that, when they meet, cancel the space between them. That cancellation of space produces the illusion of an attractive force between particles with opposite "charge". Particles with the same charge express resistance (particle vs particle or antiparticle vs antiparticle) and thereby create space.

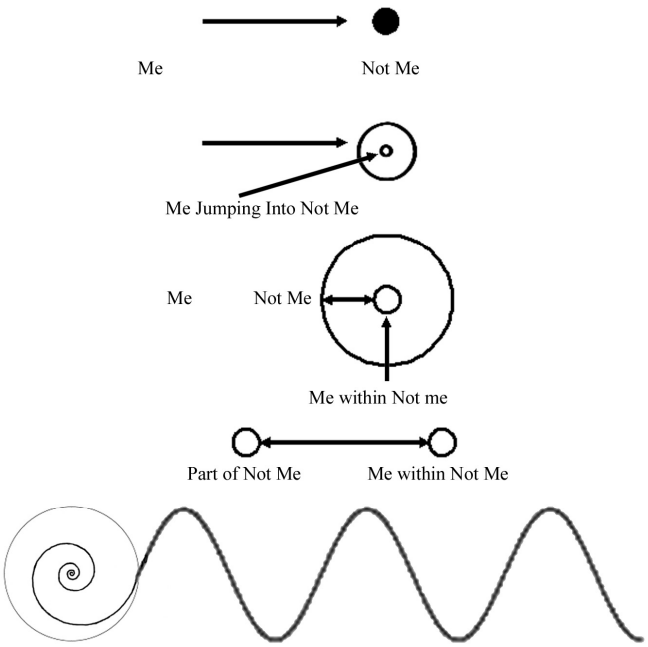
The master stroke of creation is to lock some positrons in the center of a fuzzy whirling quark maelstrom of a shell game so that electrons can not get close enough to annihilate with their would-be anti-partners. Their photon/anti-photon spray gets misdirected just enough to make a stable proton and a fairly stable neutron possible. With these two types of baryon we can create stable nucleons. Each proton at a low enough level of excitation holds an electron in a discrete vibrating pattern nearby and these pairs of charged particles can interact with other atoms to exchange information and build complex structures.

The "me" within the not-me is a locally defined me by definition. The primordial me

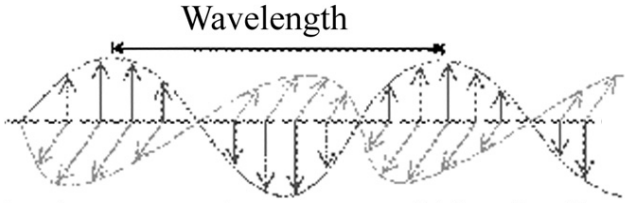
outside the not-me is non-local and undefined by a backward propagating definition, but takes on the flavor of any defined me's. The energy density decreases as the photon spirals outward thus allowing the photon to accelerate, whereas an electron under a magnetic influence spirals outward and accelerates as the magnetic field it passes through appears to increase due to its faster speed. Thus photons and electrons behave in a complementary fashion.

The electron emits photons and absorbs antiphotons. The positron inside a proton emits antiphotons and absorbs photons. The two combine to form photon-antiphoton pairs that pass between the two "charged" particles, photons moving forward in time, and antiphotons moving backward in time. The interaction of this electromagnetic current through space cancels out the illusion of space between the two particles so they appear drawn together. Opposites come together to restore the unity of wholeness in which there is no space or time.

When electrons interact with electrons, the photons create resistance with photons, creating more space between the electrons. When protons interact with protons, the antiphotons create mutual resistance that generates space. However, if the protons get closer than a certain distance, the black hole gravitational influence overcomes the electrostatic repulsion, and the protons bond together. Standard theory attributes this to the strong force mediated by "gluons" that for some reason have "asymptotic freedom" and lose their force over only a very small separation distance. More likely, because all protons look alike, the protons coalesce into a superluminal vibration pattern that resembles a cluster of nucleons forming an atomic nucleus. As fusion technology advances, the details of this will become clearer.

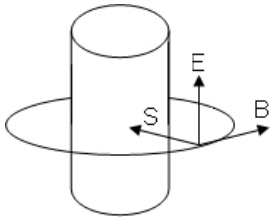


Electon: Photon spirals out from a point source at a cyclotron frequency and becomes a wave in space when it reaches the escape velocity *c*.



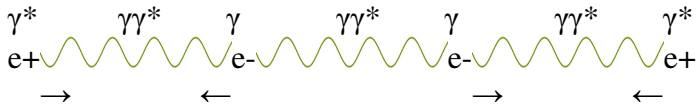
An electromagnetic wave moves bidirectionally through space and vibrates here vertically due to its electric component and horizontally due to its corresponding magnetic component.

In the above diagram you can see how the three orthogonal aspects of electromagnetic phenomena generate the illusion of 3-D space. The energy of EM radiation is in the frequency, but it is transmitted from emission at a source to absorption at a terminal via a photon energy packet. Relative to the transverse EM wave, the radiated energy is longitudinal (following the Poynting vector). Coulomb's law shows how the electric force forms between two charged singularities along the radial line between them as the inverse square of the separation. An interesting situation occurs when an electric current flows through a wire. The electric component flows with the electrons through the wire, while the magnetic component forms a field shaped like rotating rings or tubes that surround the wire. In the case of an incandescent light bulb or an electric space heater, the tendency is to assume that the energy given off by these fixtures comes from the electric current that flows through the wire, usually courtesy of the local utility company. However, if we pay attention to the principle that the electric vector (***E***), magnetic vector (***B***), and energy bearing Poynting vector (***S***) are all mutually orthogonal ($\boldsymbol{S} = \varepsilon_o c^2 \boldsymbol{E} \times \boldsymbol{B}$), we realize that the energy does not come down the wire from the utility company. The AC electricity in the wire acts as a pump (DC also works, but over shorter distances). This pump sucks available energy along the ***S*** vector from the environment into the wire. As it concentrates there, the wire heats up and begins to glow, radiating the accumulated light and heat energy back out into the environment. As the electrons flow along the wire, energy is drawn into the wire and absorbed by the drifting valence electrons in the wire. These excited electrons then relax back to their least excited state by radiating off their excess heat and light. As long as the current flows, they continue the process of excitation and relaxation. So the value of such devices is to momentarily focus ambient energy into a small local area. (See Feynman's **Lectures on Physics**, Vol. 2, 27-5, "Examples of Energy Flow".)

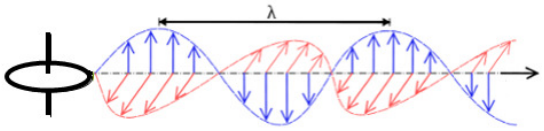


In the case of a wire carrying a current the magnetic vector **B** forms a ring around the wire and the Poynting vector **S** points into the wire, energizing its electrons that then radiate the energy back out in the reversed direction.

A photon's motion in space is like a virtual pulsation. The flow of energy per unit area per second is $S = \varepsilon_o\ c\ E^2$, because the magnetic vector magnitude is 1/c times the magnitude of the electric vector. When you add the magnetic component to the electron model above you get something that looks somewhat like a doughnut, because the magnetic component oscillates up and down the axis of the electron's "spin", giving it magnetic poles. The amplitude of the magnetic component matches that of the electric component, as you see from the transverse photon wave traveling in free space. The photon starts out small at the center and then expands until it matches the characteristic wavelength of the electron's radiation. (That wavelength may also be shifted by external forces acting on the electron.) The three fundamental "twists" give photons their three-dimensional wave quality (two transverse and one longitudinal) and give us a an illusion of a three-dimensional universe. All photons represent the exchange of energy between two charged particles or the annihilation of particle pairs. All sensory perception results from interactions between photon pairs and charged particles. The photons flow from electrons to electrons or electrons to positrons, and the antiphotons flow from positrons to positrons or positrons to electrons.



To understand the charge interaction a larger perspective is necessary. The flow of charge is a dynamic nonlocal electromagnetic flow in both space and time. In the above sketch, e- represents electrons, and e+ represents positrons (the latter usually embedded inside protons). The photon-antiphoton flow is along the wavy lines. Photons (γ) flow from past into future. Antiphotons (γ*) flow from future into past. They balance in the present moment. Electrons have a photon-biased precession, and positrons have an antiphoton-biased precession. The arrows indicate the flow of force. Two electrons and two positrons form a charge unit, like charges repelling, and unlike charges attracting. The attraction and repulsion is due to the creation and de-creation of space. Overall time balances out to form the present moment. The boundaries of the charge unit are usually positrons embedded in protons to generate a buffer edge, but as shown above, the ensemble is unstable and collapses back into photon pairs. The protons usually repel each other unless they get close enough so that they merge into a resonant cluster. Neutrons act as a further buffer to allow stronger gravitational interaction. The ensemble as shown is a potential neutron. From this analysis it is also clear that helium with two protons, two neutrons, and a Cooper pair of electrons is the most natural and stable element. This becomes even clearer as we delve deeper into the structure of the proton.



An electron has a photon-biased pole and precession. A positron has an

antiphoton-biased pole and precession. An electron has spin – ½ and negative charge. A positron has spin + ½ and positive charge. (Positive and negative are conventions.) Energy flow is bidirectional through time along the photon pair trajectory line (two-headed arrow also shows wavelength). The red arrows show the electric component, and the blue arrows show the magnetic component. The drawing is not exactly accurate. The photons spew out in all directions like the rotating beacon from a lighthouse produces a pulsating beam, but with also the secondary rotation-precession.

Deeper Spin

Now we have enough background that we can start to talk more deeply about what spin is. According to modern physics, a photon, and other gauge bosons as well, have spin 1. Neutrinos, electrons, and protons (and their constituent quarks) each have spin 1/2, and mesons are thought to have net spin 0. (We will consider heavy bosons, quarks, mesons, and baryons in the next two chapters.) Atoms are particle ensembles, and so they can also have composite spins. We simply add up the spin numbers of the components and the ensemble has either a net integer spin or a net half integer extra spin depending on the sum total of spins. In general, particles or ensembles with whole number values of spin behave more like bosons, and particles with a half-integer extra spin behave like fermions. The elementary charged fermions are spin ½. What does this mean? It means that the photons running around in circles begin as electrical vibrations. When the photons wrap around on themselves, the vibration becomes a cyclical ring. The electrical vibrations also have a magnetic vibration that is normal to the electrical vibration. When the electrical vibration degenerates into an orbit, the magnetic vibration is rolled up into a little pole that sticks out normal to the electrical band. This turns the electron into a little magnetic top with north and south poles just like an ordinary magnet, with the difference that it is quantum mechanical and has fixed values. This set of poles gives the electron magnetic moment. The motion of the photon vibration's "forward" whirl propagation is constant at c. (In a classical model the electron is a point particle, for if it had a radius, the surface would go faster than light, so it can not be a solid particle and must be the whirling photon emerging from a point singularity -- with an extremely small radius on the scale of 10^{-17} meters or less). Charge (a "pressure" of pseudo-mass per second in **Mech a**) is constant, and the speed of spin is a constant c at the event horizon from which photons propagate into space. The circulation of the electron's charge due to the “whirl” of the photons generates a dipole magnetic field, so the electron intrinsically is like a small magnet with poles on its rotational axis. The spin magnetic moment for electrons is:

* $(\mu_S = - g_s \mu_B S\rightarrow / \hbar)$

The spin vector ($S\rightarrow$) for the electron is $\hbar/2$, and the Bohr magneton $\mu_B = (e/m_e)(\hbar/2)$, where (m_e) is electron rest mass, (e) is the charge quantum, and $\hbar$ is the reduced Planck constant. The dimensionless g-factor ≈ 2 and corrects the classical equation in light of QED. We plug in for μ_B and get $\mu_S \approx \mu_B$. The ratio (e/m_e) as we have seen earlier is the quantum electron frequency, which is like a quantum clock at 1.75882×10^{11} Hz (or more precisely, rad / s·T, quantum mechanically refined to γ_e).

Charge and rest mass are quantum constants. The wavelength of the photon involved determines a particle's mass, so the mass of any "point" particle can have different values, but is a rest-mass constant for each type. The charge is determined by *c* and the spin. The pictures you see of little top-like electrons in physics books are really pretty close to the right idea, except that the poles are more pipe-shaped. These magnetic tops have precession just like ordinary tops, but are influenced more by charge in the field than by gravity and they can spin on the precession axis. However, there is one special feature for the quantum tops. They are subject to a kind of quantum uncertainty. If you send electrons through a Stern-Gerlach device, you can separate them into spin up and spin down relative say to the *z* axis and will find half are up and half are down. If you then filter out all the spin down electrons, and only send the spin up electrons through another S-G device oriented for the *x*-axis, you will then find half are up and half are down relative to that orientation. If you then filter out the *x*-axis down electrons and only send the up electrons through another S-G *z*-oriented device, you will again get half up and half down. The "memory" of the up-ness of the prior *z*-orientation selection is lost. This makes sense, because the inhomogeneous S-G field deliberately aligns the particles according to the field orientation. When the *z*-oriented electrons are sent through the *x*-oriented filter, they enter with random orientation to *x* and are then re-oriented half and half. When they go back into a *z*-oriented filter, they are again as if orthogonally random and thus are sorted 50-50 again. So this is not really mysterious. The spin scrambling is inevitable no matter how you tweak the system. It is really just a matter of switching observer viewpoints.

Physicists make the concept of quantum spin magnetic moment in the spin ½ particles very obscure and mysterious in every text I have read, including Feynman, who most of the time is a master of clarity. Feynman just begs the reader to trust him on why fermions are quantized with spin ½ and bosons are quantized with spin 1. He says, "The explanation is deep down in relativistic quantum mechanics. This probably means that we do not have a complete understanding of the fundamental principle involved. For the moment, you will just have to take it as one of the rules of the world." (**The Feynman Lectures on Physics**, Vol. III, Lecture #4-3.)

I think the model I have built is quite simple and clear. Photon-antiphoton pairs have spin 1. Experience it for yourself. We experience a stream of antiphotons as a stream of attention. Stand up and look out at your environment as you slowly rotate in a clockwise direction. Pay attention to your surroundings. When you have completed a single clockwise rotation, your environment will have rotated counterclockwise one complete rotation. The rotation of your attention is just ½ of the boson rotation. The environment's rotation is the other half – the rotation of the light field. Light-attention (photon-antiphoton) rotation therefore has a spin of 1. If you rotate your uplifted hand (palm facing up) once around counterclockwise, your attention is observing from beyond your palm and you see it as a fermion, as if it is an object of perception. This is only half a rotation. You must rotate it again clockwise in order to complete a full rotation This demonstrates the difference between boson rotation and fermion rotation. Bosons experience from wholeness. Fermions experience from separation. The trick to unifying the two types of rotation is to understand that you as observer are always unified

with whatever you observe, and the separation is a belief you have superimposed on your perception. An electron is always linked via light-attention to all other electrons and positrons (protons) and exchanges energy with them, the same way your heart is linked to every cell in your body via the circulation of blood.

Any high school student can understand these principles: *c* is a constant velocity for photons, and the energy of the photon is in its frequency. The electric and magnetic forces are normal to each other. This latter concept is something anyone can observe both in tops and in electromagnetic phenomena once you understand that the electric component produces the primary spin and the magnetic component is the secondary spin. These are the two complementary spins. The behavior of rotating systems is echoed at the macroscopic level in the behavior of physical tops and gyroscopes in general except for the special quantum feature that the “spin” is really photons and antiphotons winding and unwinding from and to the singularities of the charged leptons. The "normalness" of electromagnetic phenomena is also observable at macroscopic levels, magnified by collections of quantum particles. The nature of rotation is that the axis of rotation is always a phase wave normal to the rotation. Precession provides the third orthogonal motion. The axis of rotation itself rotates orthogonally. (Refer back to my rough sketch of an electron.)

Given that there are two, and only two, possible relative orientations of a particle with spin magnetic moment – spin up and spin down (clockwise or counterclockwise) -- this means that fermion particle ensembles build in increments of +1/2 (particles) or -1/2 (antiparticles). However, it turns out that the spin distribution in protons is not as simple as just adding the spins of the quarks, which was what was initially assumed until an experiment in 1987 under the European Muon Collaboration showed that much of the spin was **not** due to the quarks, and that the quarks statistically were about evenly distributed as to up and down spin. The quarks make up perhaps a little over 50% of the proton spin. The rest is now (since 2008) thought to be from the quark's "spatial angular momentum", relativistic effects, and aspects of Quantum Chromo-Dynamics Theory. In my early work on Observer Physics I predicted without detailed calculations that the spin of the quarks in the proton would be ≥ 1/3 of the total, because of the presence of other spin 1/2 lepton components in the ensemble. The quarks could never make up anywhere near to 100% of the spin. The proton ensemble consists of 3 quarks and 6 leptons for a net extra spin of 1/2, according to current Observer Physics theory, and this also determines the quantum unit charge held by the proton.

I proposed earlier that it is the energy of a particle expressed as its potential and kinetic energy that expresses the conjugate of gravitation. What motivates that energy? It is an expression of the electrical and magnetic fields. How do we know this? We have two indications. First, the motion of objects is controlled via that force. Second, we see that the Union particles are created in a perfect equilibrium due to the balance of equal and opposite gravitational and electrical forces at their crossover point. Thus the electrical force must serve as the conjugate to the gravitational "force" (the latter really being a relaxation rather than a "force"). It expresses this relation as potential and kinetic energy and the observable phenomenon of motion in dynamic systems.

The B_u^2 structure of the subatomic particle is an example at the finest level of creation of phase conjugation and four wave mixing. The gravitational and electrical forces form one conjugate system. The black hole radiation and suction form another conjugate system. The two are normal, but wrapped around in a spherical geometry. It is a prototype.

What are electricity and magnetism? If the mass resonances are determined by the constants, what determines the values of the constants?

Ultimately the three "hairs" are the conjugate reflections of three aspects of the observer. So we must go back to our analysis of the way undefined awareness becomes consciousness and objective creation. We mentioned A, B, and C: Awareness, Boundary, and Cancellation. Awareness inherently is undefined, but it contains as an undefined possibility, the potential for definition. This is the origin of potential energy. The energy of definition arises from Cancellation, which we called the Will aspect of undefined awareness -- Aware Will. This is fundamentally a negation of undefined awareness. It is thus what we call Resistance, even though, from the standpoint of a Self, it appears to be Desire. Any Desire is a Resistance to undefined awareness.

The expression of Will to define something results in a Boundary. This defines a creation. The creation is a resisted resistance. It is a second order Resistance. If we call Resistance (R), then a Boundary is R^2, and it serves to separate creations from each other by a radial distance (as seen in Newton's gravity equation and Coulomb's law). The movement of the Will to define is always the same wherever it goes. We can define its velocity of Cancellation via pure non-local Will as W, an as yet underived superluminal velocity, and via attention as *c*. The value of a Boundary is then c^2, and the value of a non-local background in which c^2 exists is W^2. This defines an area of consciousness within a field of awareness. By the initiation of Will, undefined awareness becomes transcendental witness Awareness observing a creation. This is now not undefined awareness, it is consciousness as a local phenomenon embedded within unbounded and undefined Awareness!!

Each of these three values -- A, B, and C -- exists in its separate dimension. Each dimension is orthogonal to each other dimension in mental space. We give a name to the "difference" of something as a dimensionality. By creating dimensionality, things can be separated, and thereafter potentially **abandoned** by attention. Something exists in its own particular dimension, and can even coexist with other things in other dimensions without interference. Or there can be rules for crossover effects, or interference, or exchanges between dimensions. It depends on the viewpoint one takes.

The three fundamental dimensions of undefined awareness, (A, B, and C), form the three hairs (mass [A], spin [B], and charge [C]), and the three dimensions of the physical space that we experience. The fourth dimension is the transcendental dimension of the Witnessing Observer. When the Witness exercises Will, takes a viewpoint, and begins observing his world, time begins.

Cancellation is the subjective Will. The objective conjugate of the will is gravitation. When the witness desires, gravity appears. But the witness desires and then abandons his desire, shifting orthogonally back to his inherently transcendental status and avoiding the responsibility of experiencing the gravitational reflection of his desire. Thus the abandoned gravity has "lost" its partner, and makes one up out of the contradictory resistance of the Will. This manifestation in the physical world of the resistance of the will is the electrical charge (resistance to the gravitational collapse of the me not-me dichotomy back into unity). Spin and charge are mutually orthogonal, because one must rotate to define a boundary, and that sets up a binary charge structure. (Try drawing a closed curve on a piece of paper without "rotating" 360 degrees relative to a center point enclosed by the curve.) The motion of awareness flowing **through** a boundary as it cancels is attention. (Make a circle with your thumb and fingers – define a boundary – and then peer through it. The peering is orthogonal to the boundary.) The directedness of attention is in a space-time-mental geodesic. The conjugate of an attention particle wave is a photon particle wave, as we discussed (the light that meets your eye as you peer through the hole made by thumb and fingers). The alignment of attention and will becomes orthogonal when the observer shifts viewpoint to Witnessing after having willed. So the direction of the photon wave propagation is now normal to the expression of will which has become gravity and electrical charge.

This is rather abstract discussion and may require some digesting. Take a break, go for a walk, and get back into experience.

Exercise: Take a walk. Pay attention to your attention. You will notice that most of the time habitually you live your life with attention normal to the gravitational force "vectors" of our planet. When you sleep or die, you relax and shift dimensions. You lie down and your attention loses focus, and then shifts dimension and realigns with the gravitational force vectors and its physical conjugate, the abandoned charges. The dreams you have in sleep are mostly electrical discharges of stress from abandoned creations.

The Boundary of a creation is in yet another dimension. This is the abandonment of abandonment. This is a real illusion. We now view the world as separate from us, and in addition we view a creation as separate from the rest of creation. This is a second order resistance. Most of physics is concerned with describing how objects interact. So physics is the world of second order resistance. Thus Einstein found that the relation between energy and mass is:

* Energy = $m\ c^2$.

The m is the defined localized inertial resistance that we call mass. It is the reflection of one's Self that one chooses to focus attention on. The c^2 is the second order resistance that forms the area occupied by the inertial resistance per second per second. The time factor is determined by the Witness viewpoint. The resultant of this interaction is what we call the total energy of a creation.

The Boundary is also orthogonal to the photon's propagation direction and electrical wave. This third orthogonal component is called the magnetic component. Just as attention is a transverse wave that has three orthogonal components (Awareness flowing through a Boundary by means of Cancellation), so the photon wave is "transverse" and has three orthogonal components: propagational direction, electrical vibration, and magnetic vibration. These are the physical reflections of attention and resistance in three dimensions of space plus time to account for the appearance of change.

The energy density of the E-field, say between the plates of a capacitor, is like this:

* $uE = (\varepsilon_o / 2)\, E^2$.

The energy density of the *B*-field, say in a current-carrying toroid, is like this:

* $uB = (1 / 2\, \mu_o)\, B^2$.

The two fields are related in a general way:

* $E = c\, B$.

The velocity c is related to ε_o and μ_o as follows:

* $c^2\, \varepsilon_o\, \mu_o = 1$.

Thus:

* $uE = uB$.

This means that the electric and magnetic fields play equal roles in electromagnetic energy as it moves through space.

Thus,

* $u = uE + uB$.
* $u = \varepsilon_o\, E^2$.
* $u = (1 / \mu_o)\, B^2$.

If we assume, given isotropic media, that the energy flows in the direction of the wave's propagation, we get the Poynting vector:

* $(S\rightarrow) = (1 / \mu_o)\, (E\rightarrow) \times (B\rightarrow)$.
* $(S\rightarrow) = c^2\, \varepsilon_o\, (E\rightarrow) \times (B\rightarrow)$.

The conjugate Poynting vector $(S\leftarrow) = (S\rightarrow)^*$ is therefore the flow of attention energy in consciousness. The electric and magnetic fields represent the force of abandoned

attention that manifests in two other directions orthogonal to the flow of attention and its conjugate, the wave propagation.

Where do the values of the constants come from? They arise naturally from the geometry of 3-Space. We have already derived the D-Shift operator % from geometry. This operator allows us to shift scales. Once we decide on a scale in which to operate and select our units of measurement, % assumes a relative value. So do all the other universal constants. The numerical values of the units are arbitrary, but the relations of the constants are universal and invariant. We will have to explore this concept of invariance and why it is important in the next chapter, and then we will begin to see how all the values of the constants arise together as a coherent wholeness. But assuming that this is the case, the various ratios of the constants are what remain to be determined. Their units just indicate their dimensionality at the scale we have selected for our viewpoint of the creations with which we are playing.

Planck noticed that if we start from the relationship ($h\ G$) instead of ($\hbar\ c$), the masses cancel out and we just have a lot of velocity whipping around to the beats of interacting clocks.

* $(h\ G) / s^2 = 44.2\times10^{-45}\ m^5 / s^5$.

So he stuck in c^5 constant 5-D Velocity to see what would happen. He soon ended up with Planck time.

* $(h\ G) / c^5 = 1.8225\times10^{-86}\ s^2$.

Taking the square root, he got the Planck second, T_P. Since this is the square root of a quadratic expression, we can get a second or an anti-second. So we can count Planck Time forwards or backwards.

* $T_P = \pm1.35\times10^{-43}$ s. (These are rounded figures).

Incidentally, with our D-shift operator in hand, we can define several other cosmic clocks: Here are their frequencies relative to standard seconds.

* Light Speed-to-Photon/D-Shift frequency = $(c / \%) = 9.4876\times10^7$ Hz = 94.876 MHz. (The inverse of 1.054, the ratio of a reduced Planck's constant second.)

* The Charge-to-Space frequency = $(e / \varepsilon_o\ \%^3) = 5.71\times10^{-10}$ Hz. (ELF)

* The Gravity-Space frequency = $(G\ \varepsilon_o)^{-1/2} = 2.43\times10^{-11}$ Hz. (ELF; the fundamental frequency of a graviton?)

* The electron charge-to-mass frequency: $e/m_e = 1.75882\times10^{11}$ Hz.

High precision work in physics generally uses an atomic clock (an oscillating atomic

structure.) The gravity-space and charge-to-space clocks have frequencies so far into ELF range that they are not very practical for us. We haven't even been able to detect gravity waves for sure yet. The gravity clock is very suggestive, because it shows the interaction of the gravity constant with the permittivity of photons in the vacuum. This reminds us of the interaction of ($\hbar$) and (G) that Planck explored. This clock seems to operate by the beats of an interference pattern generated between gravity and electromagnetic exchanges. Any detection of gravity waves is via EM signals, so we must be very clear about what we are observing, and at present we do not have very precise measurements of G.

Very Slow Speeds

Is there a slowest speed limit? A lower speed limit seems as absurd as an upper speed limit, yet light speed is claimed to be the upper limit for mass to travel. The quantization of energy by Planck's constant and Heisenberg uncertainty ensures that you can't have a "something" with mass that moves at zero velocity. That "something" must have some energy or it's nothing, and that implies some tiny jiggling must be present for something to exist. The jiggling comes from the creation and annihilation processes within the vacuum state. So this is another limiting condition on the range of Heisenberg's uncertainty relation. Heisenberg gives us uncertainty, but that does not mean that you can plug in any absurd value and get it to work. The mass component is limited by the mass of the universe. The velocity component for an observer to observe is limited by > 0 and c, and thus there is a range of quantum jiggle. The position element is limited by the ranges of all the other limits and ($\hbar$) which seems fixed, like an anchor. That is the space of uncertainty we can play in as long as we play by the rules of inertial mass and subluminal velocities in the world of "energy".

Let us say the Planck superluminal velocity (P_v) is called "Big P_v" (P_{vb}) and consists of 1 meter per Planck second, that is about 1 m / 10^{-42} s = 10^{42} m/s. Such a speed crosses the known universe in a blink of an eye. Then we can use the Velocity Equation to calculate a slow speed limit and find "small P_v" (P_{vs}).

* $(P_{vs})(P_{vb}) = c^2$.
* $(P_{vs}) = 9\times10^{-26}$ m / s.

That is pretty slow!! It would take around 2.85×10^{19} years to move one meter at that velocity. P_{vs} is the inverse of the size of the visible universe! The age of the universe probably hasn't yet gotten to 10^{18} seconds. So this cosmic turtle has barely started to crawl across his meter stick. Maybe all creations must stay between the two speed limits, (P_{vb}) and (P_{vs}), with (c) in the middle. We live most of the time at a comfortable average pace of around (1 m / s), which means nothing but that we chose units convenient for the space/time scale we are used to. Space and time are undefined except in their relation to the constants, geometry, and the observer's viewpoint. Because velocity is the ratio of distance to elapsed time, the geodesic trajectories of particles warp as velocities increase, or as masses increase -- the two being equivalent in relativity and quantum mechanics. Time is a measure of energy, which is another way of measuring mass. So we also can express Heisenberg's relation in terms of (Energy)(Time) ≥ $\hbar$, as

we mentioned above.

The observer can move about in the space/time world as he pleases or stay aloof and transcendental, which is where he or she is in reality anyway. All we have to work with is a set of relationships. In order to quantify the relationships with numerical values, we must make one selection as observer. We must choose one arbitrary unit as the basis for our relationships. It can be distance, time, energy, or perhaps something else. These are all reflections in different dimensions of the same thing. The constants give the crossover ratios for converting from one dimension to another. Our range of velocity goes almost 77 orders of magnitude (using a base ten system of counting with the D-Shift Operator) when we look at it in terms of Planck time and the two "speed limits".

The number 9 relating to the number 10 forms the dimensional crossover between orders of magnitude and physical dimensions. We have noticed the behavior of calculations done with multiples of 9, but that is all due to our using a base ten counting system.

We have already discussed how (ε_o) and (μ_o) arise in the theory of electromagnetism as constant factors related in the manner of the Velocity Equation to (c^2). How does this relate to the phenomenon of electrical charge?

The elementary unit of charge (e) is one of the major puzzles of physics. The value of the coulomb quantum unit in which we measure charge can be derived from our other units. Charge is a ratio of mass to time and is measured in coulombs (**Mech a**). Current is a flow of charge per second, measured as amperes, that is, coulombs / second.

The elementary charge unit e was first measured experimentally in the oil-drop experiment of Robert Millikan and found to be:

* $e = 1.602\times10^{-19}$ C. (His first measurements were slightly off this value.)

Comparing the Charge-to-Space frequency to the Planck second, we get:

* $(e\ S_P / \varepsilon_o\ \%^3) = 7.6\times10^{-52}$.

This is a universal dimensionless constant, similar to the ratio of the electric force (F_e) to the gravitational force (F_g).

The experimental value of the unit charge comes very close to: $(e) = 16\times10^{-20}$ C, which suggests that charge is related to geometry via the squared ratio of the area of a sphere to the area of a circle with another small factor involved and a scale factor:

* $(As / Ao)^2 = 4^2 = 16$.

The scale just tells us that the charge quantum operates at the scale level of subatomic particles. The appearance of 4 squared is no surprise, since electrostatic charge distributes evenly over the surface of an object, and a sphere is the smallest

area-per-volume we can get. To get the charge to flow -- that is, discharge -- which is how we know there WAS a certain charge on an object, we have to bring in a second object that lacks charge or has an opposite charge. This generates a flow, which we can measure. We have two spherical areas interacting. This gives us 4^2 as a key factor.

From our analysis of mass, we see that the "pseudo-mass" generated by electrostatic force is also un-manifest unless it interacts. You can not tell the mass of a planet without it interacting with some other body. The mutually non-interacting quality of photons also indicates their inherent "masslessness". The mass and the "pseudo-mass" exist only as potentials. The potential is determined by the resistance of the observer (directly) or the system (indirectly). It is like the coefficient of friction for a wood block resting on a horizontal table. If the block sits still, the coefficient may exist in theory, but there is no friction. It is just fictional friction.

This is one value of meditation. You can temporarily transcend life's frictions by sitting quietly in a quiet place. Friction in the case of a motionless object resting on a surface is a potential in the same manner that a ball held in the air has a gravitational potential relative to the earth. Both are imaginary potentials that can only be verified by dropping the ball or by moving the block. Friction on a block acts like antigravity. For the ball we have the drag of the air literally acting as antigravity. If the atmospheric “drag” is greater than the gravitational pull, the ball floats in equilibrium or may even rise upward like a helium balloon.

We may believe very strongly in friction and other forms of resistance. But ironically the cause of the friction or other resistance is the very strength of our belief in it.

Natural laws are beliefs that are held so firmly that they govern the world.

Harry Palmer once posed a wonderful question for people to contemplate: "Can God create a stone so heavy that he can't lift it, so real that he can't make it disappear?" What do you think? What is your experience?

Charge is only verified by an interaction that causes an interactive current of exchange. In gravitational and electrical force relations the interaction takes place with a conjugate vector pair that runs between two singularities. But that 1-D conjugate interaction magically generates a 3-D sphere of influence with spherical (non-Euclidean, general relativistic) 2-D area equipotentials that radiate out from a theoretical or real "center" point of common singularity between the two objects. Do you begin to see the relation here to the binary star systems we spoke of earlier?

However, when we look closely at our model of how quantum charge originates in a particle, we run into trouble with the mysterious neutrinos. Everybody has trouble here, and this is partly because neutrinos are so small and fast and non-interactive with the rest of the world. They are hard to study in detail. (The difficulty may be due to going about it in the wrong way. It usually is.) The problem with neutrinos is that they

interact as fermions, which suggests that they have a tiny amount of mass. They have half-integer spin, but no charge, and electron neutrinos are considered close to massless elementary "point" particles. In the next chapter we will continue investigating the nature of charge, a quantum property of matter whose behavior is described in detail but remains without any clear explanation.

We also will consider one of the major fundamental assumptions of physics. It is referred to as the principle of **invariance**, also known as conservation or symmetry. The notion is that the universe fits together in an orderly way by various symmetries. What we often see is "spontaneously" broken symmetry apparently due to selecting a "weird" viewpoint of observation. Invariance means that under transformations of different kinds, the structure (and its mathematical description) remains constant. It means that regardless of your viewpoint as observer, the laws of physics work the same for everyone everywhere. Conservation and symmetry are two ways that we can recognize this principle at work. The physical constants are signs of invariance in nature. In Observer Physics we will postulate the fundamental principles of invariance from which all other invariances, symmetries, and conservancies derive, and that will be our major topic of discussion in the next chapter. We will also continue to expand our vision of the elementary particle zoo, introducing the W and Z bosons as well as the stable quarks.