Photon Theory

Abstract

While discrete forms of mathematical interpretation of reality are helpful, reality is in fact analog. To argue this point, Photon Theory (PT) is introduced. PT is a conceptual framework that identifies the subtle connection between gravity and light. PT enhances the derivation of time dilation by integrating redshift. PT predicts that the time rate of change of photon frequency will induce a gravity field. PT derives a possible alternative to the graviton called the **shift photon.** PT concludes with an experimental design for a shift photon generator more commonly known as a **gravity beam**.

Photon Theory

Photons and wave-functions cause physics to exist [2]. Photons are fundamental to all particles in the standard model. They are the carriers of causality [1] and exclude the possibility of time travel. Photons are the time keeper and the meter stick. They connect directly with gravity through their frequency and time dilation. Virtual photons are the mediators of the electromagnetic force, and permit color charge to operate so that gluons can mediate the strong force. Photons are the first and primary form of energy; their energy is stored as $E = hf$. Why are photons important enough to have a theory named after them?

Distance and time are defined with photons. One second is defined by the International Bureau of Weights and Measures (BIMP) the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom [3]. In other words, the frequency of a photon that transitions between two energy levels in a Cesium atom. The same is true for distance. One meter is defined by BIMP as the distance light travels in 1⁄299,792,458 of a second. Incidentally, that would be 30.66 cycles of a photon transition on a Cesium atom; effectively a meter-stick moving at the speed of light.

Some forces rely upon photons. Virtual photons are photons that exist temporarily. They are the mediators of Electric and magnetic fields. Electromagnetic radiation, which consists of oscillating electric and magnetic fields, are made out of photons. Virtual photons are a temporary burst of energy from the quantum vacuum; they can be considered a wave-function with energy borrowed temporarily.

The strong force, which holds protons and neutrons (hadrons) together, is mediated by gluons. Quantum Chromo-dynamics says that quarks and gluons are composed of fractional charges called color-charge. But fractional color charge is still electric charge; partial electric charges induce partial electric fields which are mediated by virtual photons. While gluons mediate the strong force, virtual photons are the unsung heroes that make color charge available and allow gluons to do their job.

The weak force has more to do with wave-functions than photons. The weak force is responsible for nucleon decay and is mediated by W and Z bosons. In a process called beta decay, the weak force causes a neutron to decay into a proton and an electron. The weak force does this by changing a quantum number called flavor. All quantum numbers are characteristics and details of wave-functions; thus the weak force is a wave-function phenomena and falls within the framework of photon theory.

What do photons have to do with gravity? Photons store their energy as frequency; in cycles per **second**. Time dilation determines how long a **second** lasts at point A relative to point B. When the photon travels from A to B, time dilation automatically changes its frequency; and changes its energy as well.

The photon is important, but it's not used for everything.

Wave Functions in Photon Theory

Wave functions, also called wave amplitudes, are the primary mathematics tool of quantum mechanics. They can look like $\Psi(x,t) = Ae^{i(kx-\omega t)}$, which is coincidentally the equation for a wave front of electromagnetic radiation [4]. They are solutions to the Schrodinger equation and are used to calculate probabilities by writing,

$$\int_{-\infty}^{\infty} |\Psi(x,t)|^2 dx = \int_{-\infty}^{\infty} \Psi^*(\mathrm{x},\mathrm{t})\Psi(\mathrm{x},\mathrm{t})\mathrm{dx} = 1.$$

Only probabilities can be measured. Wave-functions cannot be measured and are incorrectly assumed not to exist. Photon Theory states:

ALL PHYSICAL PHENOMENA EXISTS BECAUSE WAVE-FUNCTIONS EXIST.

Most fields and particles have energy content. Particles with mass have energy $E = mc^2$. Photons have energy content $E = hf$. When particles are annihilated by their anti-particle, photons are released as gamma rays. Annihilation occurs because the anti-particle wave-function cancels out the particle wave function. In the process, photons are released. Therefore, particles with mass are wave-functions with photons trapped inside. This description will be used to explain inertia and force. Particles with mass can also be described as "clusters of wave-functions" with photons trapped inside.

The Higgs field is intended to explain the origin of mass. When viewed by photon theory, the Higgs field is just the cluster of wave-functions with trapped photons. The Higgs field wave function is an inertial reference frames unto itself. All inertial reference frames are interconnected with "time dilation" wave-functions. As the photon moves between inertial references frames, its frequency can change if the gravitational potential between the two is different; that's where the Equivalence Principle comes in. It's like bubbles in a water pipe; water represents the photon's energy; photon energy is proportional to its frequency in cycles per second, and the bubbles represent time dilation and change the duration of a second. That's what makes special relativity work.

Particle-wave duality is useful, but unnecessary: all photons are waves. In fact, all particles are waves because they're made out of wave-functions. Particles appear point-like from very far away or low magnification. The city of Portland is certainly not a point, until you look at it on a world map. Particles are just clusters of wave-functions with photons trapped inside.

Why do we experience g-force accelerations from gravity and vehicular acceleration? Experimentally, g-forces induce time dilation [4][7]. These g-forces attempt to blue shift the trapped photons by changing the duration of one **second**. It takes work, $W = \int F dx$, to increase the photon energy. What is inertia? Inertia is the resistance to blue-shift of the particle entrapped photons.

Gravity, the Anti-Energy

Conservation of energy means that energy can neither be created nor destroyed; but what if energy was never really created? What if gravity plus energy is 0 = -1+1? The physics community has not reached a consensus of what causes gravity. However, **Photon Theory** states that the energy of the Big Bang, E_{BB}, **plus** the negative energy of gravity, U_{GR}, add to zero. This idea has been called the Free Energy Universe [11].

$$E_{BB} + U_{GR} = 0$$

The Big Bang began as a flash of light with energy content E_{BB}. The energy E_{BB} was borrowed from the wave-functions of the quantum vacuum. The quantum vacuum converted the energy debt, U_{GR}, into what we call the space-time continuum. More simply, eggs are energy and the egg carton is space-time. In this way, **space-time is emergent from the quantum vacuum**. For those familiar with semiconductors [8], it would be like electrons escaping the crystal into the conduction band and leaving behind holes. The electrons represent the energy of the Big Bang. The holes become space-time itself and produce the gravity field. Opposites attract and cancel. If they can't cancel, they will yearn for each other. The wave-functions of the vacuum minimize the yearning with a process called conservation of energy.

What is the evidence that the quantum vacuum, also known as empty space, is filled with wave-functions? Evidence of this comes from the Lamb Shift [6] and the Casimir Effect [14]. The energy levels of $^2S_{1/2}$ and $^2P_{1/2}$ of a hydrogen atom are supposed to have to have the same energy, but they don't; the Lamb Shift attributes the tiny deviation in the energy of $^2S_{1/2}$ with an interaction between the energy level and the quantum vacuum.

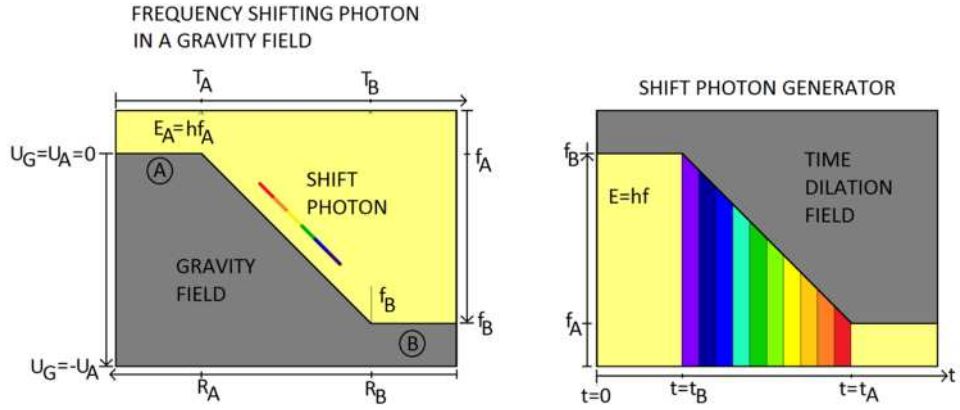

Figure 1: Gravity causes photons to frequency shift. Can a shift photon induce a gravity field? The symmetry is intended to suggest that the full range of electromagnetic frequencies is a mated pair with gravity/time dilation. Together, they add to zero.

In the Casimir Effect, two metal plates are uncharged and placed very closely to one another in a vacuum. For no apparent reason, the plates are attracted to each other. From a quantum electrodynamics perspective, space is filled with virtual particles, quantized fields and wave-functions. There are fewer wave-functions between the closely spaced plates. The pressure of these quantized fields on the outside overcomes the absence of wave-functions on the inside and pushes the plates together.

The Shift Photon

Shift Photon is short for frequency shifting photon. When a photon falls, from r_A to r_B towards a black hole, its frequency is blue-shifted and it gains energy $\Delta E = h\Delta f = h(f_B - f_A)$. To conserve energy, the increase in photon energy comes from a loss of gravitational potential energy. Note that gravity does not change the speed of a photon which is the speed of light. The average gravitational force F_{SP} that a shift photon might experience equals the loss of gravitational potential across a distance $\Delta r = r_A - r_B$, where Δr is the change in elevation. This is written as

$$F_{SP} = -\frac{\Delta U}{\Delta r} = \frac{h\Delta f}{\Delta r},$$

Time dilation between A and B makes it futile to write $\Delta r = c * time$. If we could transform the photon's frequency shift from an *accelerated frame* to an *inertial frame*, then we could write $\Delta r = c\Delta t$ where Δt the duration of the shift photon. If such a transformation exists, it means that a frequency shift Δf which occurs within a time Δt will be accompanied by a gravitational potential ΔU. Using this, we can write the frequency shift photon for an inertial reference frame as,

$$F_{SP} = \frac{h\Delta f}{c\Delta t}$$

The Shift Photon equation is the analogue to Newton's force equation $F = ma$.

Relativity According to Photon Theory

Relativity is perfectly simple, if you can trust the invariance of the speed of light. Imagine a rocket traveling 0.5c past a stationary observer. The rocket and the stationary observer "see" each other by observing each other's time dilated photons. But what if it's "Photon Appreciation Day" and the photon takes the day off? Then some other subatomic particle has to fill in for the photon. The unfortunate neutron gets to fill in for the photon. While photons always move at the speed of light and can easily catch up to anything, the neutron has mass and has to find a way to accelerate up to 0.5c. Coincidentally, he finds a high ramp with a 1000g gravity field that just happens to provide the neutron with enough $\Delta U = mgh$ to achieve a 0.5c velocity; what luck! All the neutron has to do is climb up the ladder which is a lot of work. The next day, the photon returns to work. The neutron complains that he had to climb this tall ramp in a 1000g-force gravity field. Unfortunately, he missed the rocket the first time and had to climb up again. The photon shrugs and says: "I don't have to accelerate. I'm a photon and I have no mass." The neutron, a little annoyed, says, "Well then how do you transmit signals back and forth between a stationary observer and a relativistic rocket traveling 0.5c?" The photon shrugs and says he always travels at the speed of light and can catch up to anything. That's why he doesn't need to mess around with ramps in 1000g gravity fields." The neutron begins to curse and accuses the photon of cheating conservation of energy. The photon replies, "I didn't cheat conservation of energy. My energy changes back and forth, just like yours did. However, my energy is stored as frequency, in cycles per **second**. Time dilation between the observer and the rocket automatically changes my frequency by changing how long a **second** is. Time dilation was proven by the **Hafele and Keating Experiment** [12]. The neutron makes a derogatory comment about time dilation and walks off.

Photon Theory Approach to Time Dilation

In a typical derivation of time dilation [7], an observer is watching a train car go by with a light bouncing between the floor and the ceiling. On the train car, a blue Argon Ion laser is bolted to the floor; a mirror is attached to the ceiling. The laser beams up to the mirror and reflects back to the floor. The proper time [4][7] is measured by a sensor circuit attached next to the laser that measures the time it takes for the beam to reflect off of the mirror. The train car is traveling at v = 0.82c with respect to a "stationary" observer. The stationary observer *and* the sensor circuit MUST observe the same speed of light, c in a vacuum. However, they are not expected to see the same wavelength and frequency.

$$c = \lambda f = \lambda' f'$$

The observer watches the Argon Ion laser/mirror ensemble go by at 0.82c, but is puzzled to observe a red laser. This is a consequence of time dilation and length contraction that observers see for objects that go by at relativistic velocities. Time dilation is built into the frequency and length contraction is built into the wavelength. This is the crux of the nature of space-time.

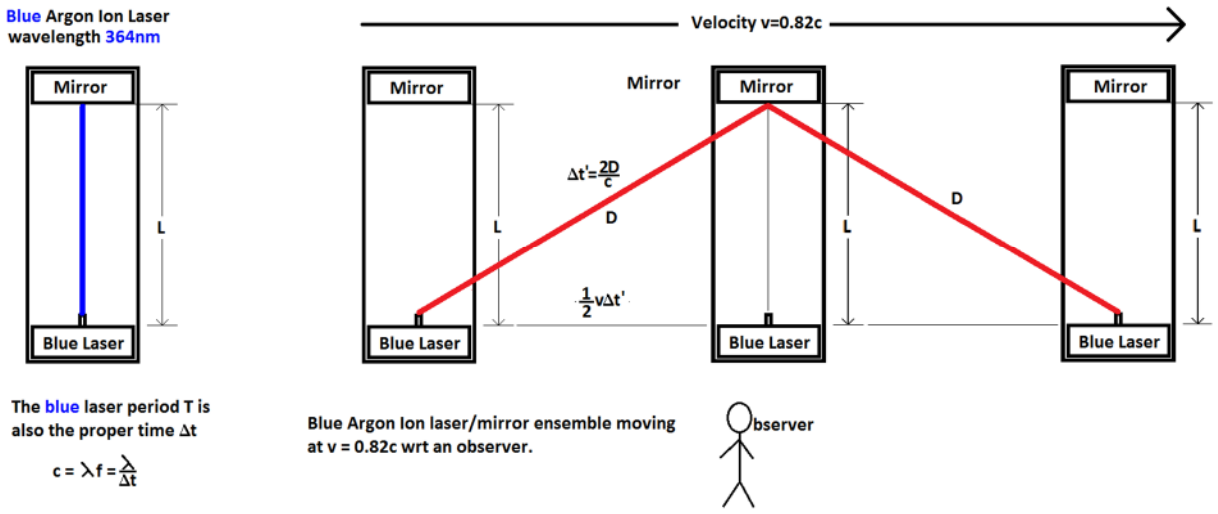

Figure 2: Redshift Derivation of Time Dilation

The frequency of the blue photons coming out of the Argon Ion laser is f. The period of a blue photon, measured in proper time, is T, and it is related to the frequency as,

$$T = 1/f$$

The wavelength of a blue photon, 364nm, is given by the equation,

$$c = \lambda f = \frac{\lambda}{T}$$

The time dilation equation says that the observer sees a period T'. Surprisingly, that period results in an observation of a red laser. From this, we can calculate the relationship between the proper wavelength and the observed wavelength.

$$\lambda' = \frac{c}{f'} = cT' = c(\gamma T) = \frac{c\gamma}{f} = \gamma\lambda$$

This simplifies to:

$$\lambda' = \gamma\lambda$$

From this equation, we can calculate the velocity of the train car as it goes by the observer. We get:

$$\frac{\lambda}{\lambda'} = \frac{1}{\gamma} = \sqrt{1 - \frac{v^2}{c^2}}$$

When we solve for v/c, we get:

$$\frac{v^2}{c^2} = 1 - \left[\frac{\lambda}{\lambda'}\right]^2$$

The velocity can be calculated from the proper and observed wavelengths:

$$\frac{v}{c} = \sqrt{1 - (\lambda/\lambda')^2}$$

Time Dilation

The details of time dilation are left to the experts in General Relativity. However, a layperson can still grasp one very simple idea. Time dilation means that the duration of **one second** will change from one inertial frame to the next. When a rocket accelerates to relativistic velocities, the astronauts experience g-forces. If the rocket reaches relativistic velocities, perhaps 0.5c, the engines are shut off, and the astronauts are weightless. However, their inertial reference frame is time dilated. On Earth, you will work a whole day before they've even brushed their teeth. Eventually, these astronauts will try to radio back to earth, which means transmitting photons. Those photons will have to frequency shift because they are transmitting from a time dilated reference frame. Arguably, NASA at Houston Control is also in a time dilated reference frame caused by planetary rotation and 1g gravity. We're not experts in relativity, so we'll just say that the time dilation between the rocket and the earth is $T_D = \frac{T_E}{T_R} = 3$. T_D is the time dilation ratio between the two reference frames; T_R is the rocket and T_E is the earth. The rocket pilot transmits one second at 10 THz to say, "Good morning Houston." Houston receives all ten trillion cycles; however, they are time dilated; so Houston hears in a very deep voice "Goooooood mmmooorniingg HHHoooouussston" That means that $T_E f_E = T_R f_R$ for each cycle. Due to time dilation, earth receives the photons from the rocket at a frequency of:

$$f_E = \frac{T_R}{T_E} f_R = \frac{f_R}{3} = 3.3THz$$

Massive and massless particles in a gravity field

In a gravity field, **massive particles accelerate but photons frequency shift**.

Consider the gravitational potential for a mass m that is dropped from point A to B. From Serway [7], the test mass obeys the gravitational potential energy equation:

$$\Delta U = U_B - U_A = -GMm\left[\frac{1}{r_B} - \frac{1}{r_A}\right]$$

The acceleration is calculated to be

$$a = \frac{F}{m} = -\frac{1}{m}\frac{dU}{dr}$$

The speed of light is an invariant. Therefore, when a photon falls from A to B, it does not accelerate. Appendix A derives the gravitational time dilation for a photon that falls from A to B.

$$T_D = \frac{T_A}{T_B} = \sqrt{\frac{(r_B - r_0)r_A}{(r_A - r_0)r_B}} \qquad \text{[Appendix A]}$$

Cycle quantity is conserved for the transition from inertial frame A to inertial frame B; each photon cycle obeys $T_A f_A = T_B f_B$. When a photon of frequency f_A falls from A to B, the change in elevation is $\Delta r = r_B - r_A$, its frequency can be calculated as,

$$f_B = T_D f_A = \frac{T_A f_A}{T_B} = f_A\sqrt{\frac{(r_B - r_0)r_A}{(r_A - r_0)r_B}}$$

Change in photon frequency is equivalent to a change in photon energy,

$$\Delta E = E_B - E_A = h(f_B - f_A)$$

The photon's energy changes along with its change in gravitational potential energy for an energy conserving net result of,

$$\Delta E + \Delta U = 0$$

Shift Photon Generator

The White Laser technique uses mirrors and optics to combine the wavelengths into a white laser. However, only one wavelength is pulsed at a time. When the picosecond bursts follow the order: red, orange, yellow, green, blue, violet, the shift photons are repulsive. In the reverse order, they are attractive.

The shift photon generator must generate shift photons *rapidly and repeatedly*. The unit impulse function [13] combined with digital signal processing [10] allows one to write a frequency equations for repeating shift photons.

$$f(t) = \sum_{k=0}^{\infty} \frac{f_0}{T_{SP}}(t - kT_{SP})[u(t - kT_{SP}) - u(t - (k-1)T_{SP})]$$

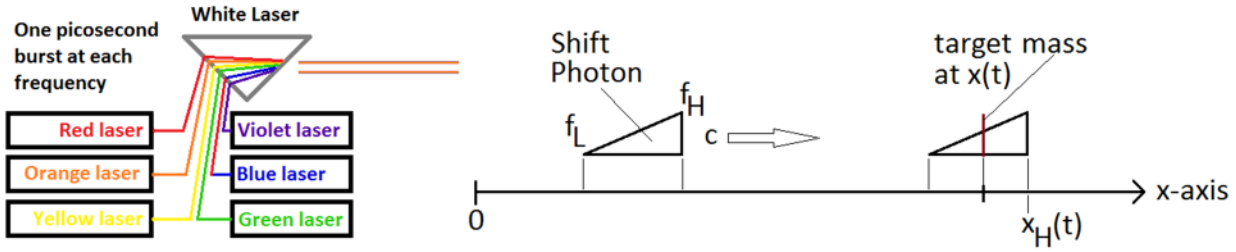

Figure 3: White laser method used to generate shift photons.

Another shift photon generator uses the multiplexer technique shown below. Microwaves are used to simulate the shift photon.

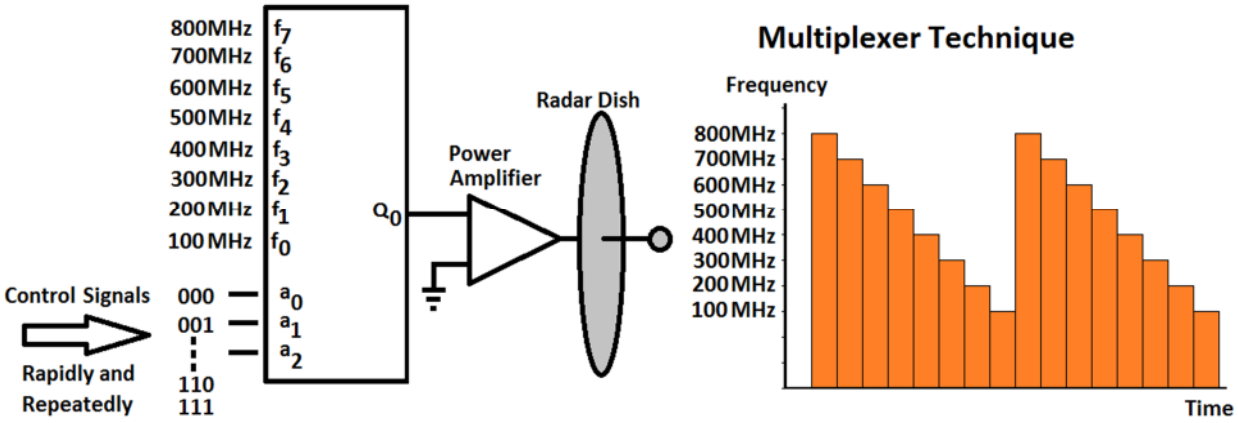

Figure 4: Multiplexer generates shift photons.

A single photon will undergo a frequency shift $\Delta f' = f_A - f_B$ along a radial displacement $\Delta r' = r_A - r_B$ under gravitational potential energy $\Delta U' = U_A - U_B$ in such a way that the photon's momentum $\vec{p}'$ will obey the function $\vec{p}'(r) = \frac{hf'(r')}{c}$. This already occurs for photons falling into or escaping a black hole. There are two issues that must be resolved to get a gravity beam to work. First, can a change in frequency Δf,

$$\Delta f = \sum_{i=0}^{i=\infty} \Delta f_i$$

be generated electronically and emitted in such a way that that $\Delta f \rightarrow \Delta f'$? If yes, then the second issue, if resolved, will prove photon theory and explain the physics of the gravity beam. The potential energy $\Delta U \rightarrow \Delta U'$ must be invariant under a transformation from an accelerated frame to an inertial frame.

If true, then a shift photon with frequency shift $\Delta f = f_L - f_H$ and duration $\Delta t = t_L - t_H$ will induce a potential energy ΔU upon a target mass m, at rest, by transferring momentum to the target mass. In doing so, the target mass will move from (x_A, t_A) to(x_B, t_B). The leading frequency is f_H. Figure 3 shows the shift photon moving to the right at velocity c; its position is $x_H(t) = ct$. In a vacuum,

dispersion should be negligible. The red vertical line is the target mass. It will accelerate to the left for this model. Its position is $x(t) = x_A + \frac{1}{2}at^2$. Acceleration is $a = \frac{F}{m} = -\frac{1}{m}\frac{dU}{dx}$. The potential energy for the shift photon is calculated by,

$$U(x,t) = -E(f) = -hf(x,t)$$

A shift photon can be thought of as a train of photons with a ramp frequency configuration. One photon with frequency f_i has a momentum $\vec{p}(f_i) = \frac{hf_i}{c}$. It would be helpful to write a momentum equation for a shift photon. Momentum is just the frequency times $\frac{h}{c}$. The frequency has to be calculated as a function of $f(x,t)$. Since the frequency ramp repeats indefinitely, it might make sense to write it as a Fourier series. Alternatively, we want $f(x,t)$ to be differentiable with respect to x and t.

Using a Maclaurin series, the frequency profile of a shift photon train can be constructed as an infinite sum with terms calculated for the nth derivative.

$$f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(0)}{n!} x^n$$

We want an expression for $f(x,t)$, $\vec{p}(x,t)$ and $U(x,t)$. If the momentum is of the form,

$$\vec{p}(x,t) = \frac{hf(x,t)}{c} + \frac{h}{c}\frac{\partial f}{\partial t}$$

then the second order term will dominate when $\frac{\partial f}{\partial t}$ gets large. This will lead to a proper derivation of the shift photon.

A shift photon period of $\Delta t = 10ps$ (picoseconds) or better across a frequency range of 300 THz is sufficient to meet propulsion requirements.

Conclusion

Photon Theory has demonstrated that wave functions and photons cause physics to exist. Particles are wave-functions with photons trapped inside; the entrapping wave-functions are the Higgs field. The shift photon equation is introduced as the frequency analogue to Newton's force equation. Quantum Mechanics and General Relativity are interconnected through photon frequency; time dilation changes the duration of **one second**, which changes the frequency. Photon Theory predicts that the shift photon will be invariant under a transformation from an accelerated frame to an inertial frame. This will prove the validity of gravity beam physics. The framework for this derivation is described. Two shift photon generator experiments are introduced. For these reason, while digital might be helpful, reality is observably analog.

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Appendix A: Derivation of Gravitational Time dilation for photon that falls from A to B

Start with the Gravitational Time dilation equation used for a Non-rotating sphere and a Schwarzschild Metric. The equation is,

$$t_0 = t_f\sqrt{1-\frac{2GM}{rc^2}} = t_f\sqrt{1-\frac{r_0}{r}}$$

where,

- t_0 is the proper time between events θ_1 and θ_2 for the slow ticking observer in the gravity field,
- t_f is the coordinate time between events θ_1 and θ_2 for the fast ticking observer so far away that gravity is negligible.
- G is the gravitational constant, M is the mass of the gravitational body, r is the radial coordinate or the Schwarzschild coordinate of distance from sphere's center, and c is the speed of light.
- The Schwarzschild radius is $r_0 = \frac{2GM}{c^2}$.

Instead of using two events θ_1 and θ_2, we use the frequency f in cycles per second, $f = \frac{\theta_2-\theta_1}{T_0}$, such that θ_2-θ_1 is the period of one cycle. For a photon that falls from point A to point B, it's proper time in A and B will be T_A and T_B respectively. The radial components will be R_A and R_B. Now, we can write the equation in terms of T_A and T_B,

$$T_A = t_f\sqrt{1-\frac{2GM}{r_Ac^2}} = t_f\sqrt{1-\frac{r_0}{r_A}}$$

And

$$T_B = t_f\sqrt{1-\frac{2GM}{r_Bc^2}} = t_f\sqrt{1-\frac{r_0}{r_B}}$$

In order to obtain the time dilation of a photon that falls from A to B, we take the ratio between T_A and T_B to obtain the time dilation T_D,

$$T_D = \frac{T_A}{T_B} = \frac{\cancel{t_f}\sqrt{1-\frac{r_0}{r_A}}}{\cancel{t_f}\sqrt{1-\frac{r_0}{r_B}}} = \sqrt{\frac{1-\frac{r_0}{r_A}}{1-\frac{r_0}{r_B}}} = \sqrt{\frac{(r_A-r_0)/r_A}{(r_B-r_0)/r_B}}$$

Then,

$$T_D = \frac{T_A}{T_B} = \sqrt{\frac{(r_B-r_0)r_A}{(r_A-r_0)r_B}}$$

Appendix B: Derivations for the Shift Photon

We start with the relativistic mass-energy equation

$$E^2 - (pc)^2 = (m_0 c^2)^2.$$

Since all particles can be decomposed into photons, which are massless, then $m_0 = 0$, so we get $E = pc$. Since the energy of one photon depends on its frequency, we can write $E = hf$. This gives us, $E = pc = hf$. Solving for the momentum p, we get,

$$p = \frac{E}{c} = \frac{hf}{c}.$$

Using Newton's second law,

$$F = \frac{dp}{dt} = \frac{h}{c}\frac{df}{dt}.$$

Another way to derive the shift photon equation starts with Newton's equation $F = ma$. Since $E = mc^2$, we can solve for mass and get $m = \frac{E}{c^2}$. Since the energy of a photon is $E = hf$, we can rewrite the force equation as:

$$F = ma = \frac{hf}{c^2}\frac{dv}{dt}$$

When photons fall from A to B, they don't accelerate or decelerate. Their velocity is always a constant, c. However, gravitational time dilation is associated with gravitational potential, and this causes the photons to redshift or blue-shift. Therefore, the speed doesn't change, the frequency does. So $\frac{d}{dt}$ is moved from the velocity term to the frequency term. Note that the velocity v is changed to c:

$$F = \frac{hv}{c^2}\frac{df}{dt} = \frac{h}{c}\frac{df}{dt}$$

The Shift Photon equation provides the mathematical framework for the gravity beam. Since electronic equipment cannot generate an instantaneous frequency change, the Shift Photon Equation is written as:

$$F_{SP} = \frac{h}{c}\frac{\Delta f}{\Delta t}$$

The change in frequency Δf occurs in a finite time Δt.