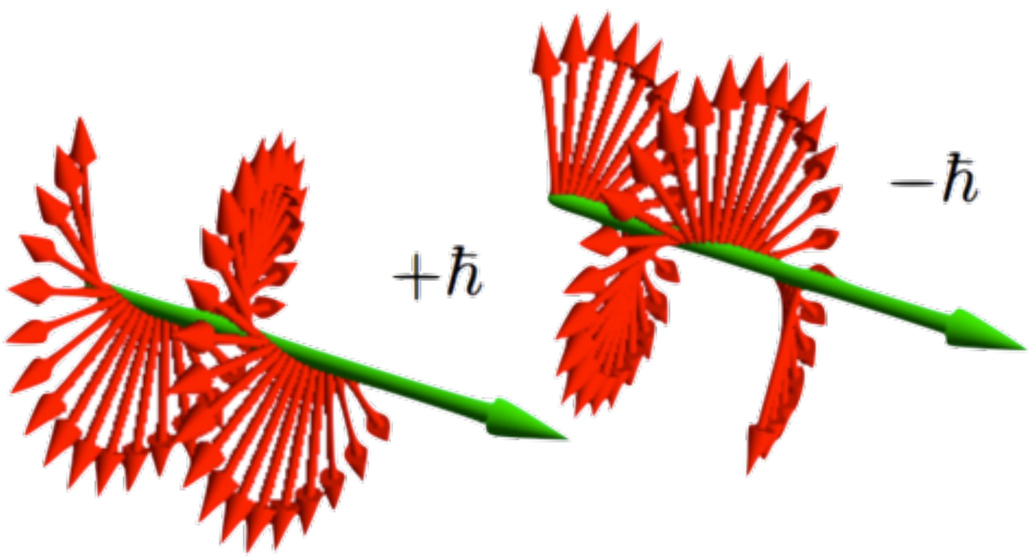
Paper 1:

On the Structure of the Photon



The Deterministic Ring Theory of Particles

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Abstract

Current quantum theory is based on probability and includes a myriad of fields, forces and force carrying particles. The principle cornerstone of physics is to determine observable values from experiments that match quantum calculations. There are several particles classified as fundamental such as the electron, the quark and the photon. The cloud of uncertainty (principle) around quantum physics has kept any deterministic explanation from been accepted in the physics community. This paper sets the groundwork to connect quantum physics with classical physics concepts.

First principles define the photon as the single fundamental particle that all other particles are made from. A geometric analysis of the photon and its measured properties are used to derive a mass equation. Mass is defined as a function of curvature and the velocity along that curvature. This mass equation is used to derive the equations of motion based on the principle of least action. The semi complete Lagrangian of the photon presented leads to Euler-Lagrange equations that agree with its measured properties. The kinetic energy of the presented Lagrangian also directly leads to the Einstein Planck relation.

Taking these first principles and applying various thought experiments, explanations are revealed including the double slit experiment, vacuum energy, the Casimir effect and a potential contributor to Dark Matter. A testable prediction resulting from the Ring Theory hypothesis is that the photons resulting from decaying particles have an offset in trajectory. The trajectory is based on the geometry of the ring based particle.

The final takeaway is that Ring Theory lays the foundation for the photon's electric fields to be generated from a charge source that can geometrically present positive charges, negative charges, positive masses and magnetic moments that appear in particles previously considered to be fundamental.

Testable predictions	**Questions Answered**
Photons from decayed particles will be offset in trajectory	Definition of Mass The Double Slit Experiment Vacuum energy The Casimir effect Dark Matter (part 1)
Note: Speculations are shown in this font color	

Key-phrases: Theory of Everything, Grand Unification Theory, Photon Structure

1.1 The General Idea

The fundamental concept of this model, usually referred to as "first principles" in a theory, is as follows:

Postulate 1:

The elementary building block of all matter is the photon.

The idea of matter made from energy is widely accepted along with particles that can decay into either two or three photons [1]. Also, particles absorbing and emitting photons regularly is standard physics, but there has never been a deterministic explanation for this. Electrons in orbit around protons are observed to absorb photons in discreet quanta of energy (e.g. heat - infrared photons). Even the Proton absorbs and emits discreet quanta of photons (e.g. MRI machines - radio photons). The idea has always been the photon energy was simply absorbed by the particle and follows the laws of physics described by the popular Albert Einstein equation:[2]

$$Energy = E = mc^2$$

Where m is the mass of the particle and c is the speed of light (a very large number). So a little bit of mass has a large amount of energy.

The goal in particle physics has been to find the most fundamental particles by colliding particles (mostly protons) at high speeds (almost the speed of light) in particle accelerators and observe what comes out. What this paper begins to show is how the photon can be modeled as the fundamental elemental particle with an underlying wave structure. All observed particles can simply be modeled as photons in orbit with each other. These orbits can be arranged in different geometric structures that reveal properties including mass, electric charge and magnetic fields. As with any theory that has the goal to unify all the forces of nature or explain the strange properties of quantum mechanics, a testable prediction should be presented. The first testable prediction will be that a particle that decays into (2) photons, such as a pion, eta meson or positronium, will have the trajectories of those photons in opposite directions but with an offset on the order of the particle's diameter and proportional to the wavelength (λ) of the photons emitted:

$$Diameter = Offset = \frac{\sqrt{2}}{2\pi}\lambda$$

This value is to be derived in Paper 3.

Picture (2) ball like photons in orbit held together by a piece of string between the photons. If the string is cut (particle decays), then the photons will fly off in opposite directions along lines that are tangent to the orbit diameter. The path is parallel but it is not collinear.

This theory is not making any great claims that current science is wrong. In fact, Ring Theory is in agreement with most science. Einstein's theories, Quantum Mechanics, Quantum Electrodynamics, Quantum Chromodynamics, Quantum Field Theory and the Standard Model all have great effectiveness in potentially describing reality. Even speculative theories such as String Theory, Quantum Loop Gravity and Geometric Unity are useful to explore and analyze mathematical models. What the Perez Model does is show how most of these theories are an approximation of Ring Theory. Indeed, another theory may come along that shows Ring Theory is an approximation. While it is popular to shoot down theories and say they are wrong, it is not necessarily productive. I consider theories that are good approximations as correct. For example Newtons's laws are very good approximations. Einstein's theory of General Relativity that is considered to have supplanted Newtons laws did not make Newton wrong, it just provided a more exact description of gravitation as curvature. Both theories are very correct. If a theory does not provide a good approximation of a particular experiment, it is not necessarily wrong, it is just not very useful. It may, however, have other benefits not yet realized.

1.2 The Photon as a particle or a wave

The photon is described in quantum theory as a particle that has a trajectory and a spin that is either right handed or left handed (along its propagation direction). It also has a quantum spin value of "1". The quantum spin value is a description of the geometry of a particle. A spin value of "1" means if a particle rotates once (which a photon does over its wavelength) it is geometrically back to where it started. A particle with a spin of "1/2" would have to rotate two times to get back to where it geometrically started, then each subsequent "1/2" spin is a duplication of the previous two rotation pattern. There is even a spin "0" description where the particle is geometrically identical no matter how little you rotate it. An example of spin "0" geometry is a sphere.

The photon's electric and magnetic field components spin (rotate) around the axis of propagation but point perpendicular to that direction (a property of transverse waves). The photon's value of the angular momentum due to the spin is either + ħ right handed or -ħ left handed, where ħ (h bar) is the reduced Planck's constant (h/2π) as shown in figure 1.1.[3]

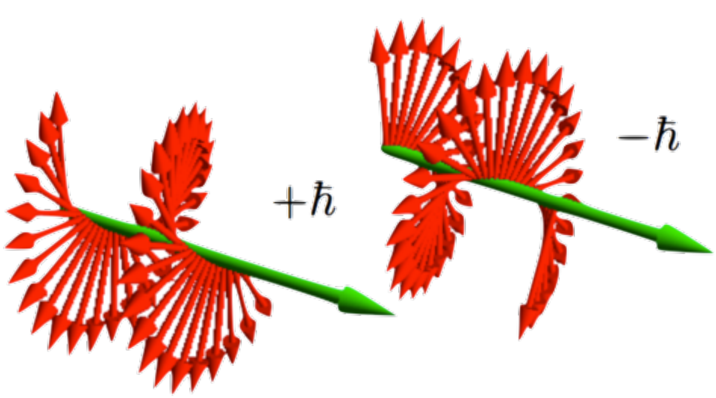


Figure 1.1

The units of Planck's constant are units of angular momentum. Angular momentum is the rotational equivalent of linear momentum and both are usually based on mass. However, photons are considered to have no mass.

The photon was described by Einstein, in one of his famous papers, as a quanta of light or quanta of electromagnetic radiation and explained the photoelectric effect. This paper was the reason he was awarded the 1921 Nobel prize in physics.[4] Typically, a single photon is described as a wave packet of energy that has a magnetic and electric field but there is no deterministic model currently agreed upon in physics. It is simply considered a localized expression of the electromagnetic field in quantum physics. Quantum physics describes electromagnetic effects in space as a vector potential that affects other charged particles. In turn, the charged particles also affect the vector potential. This vector potential is usually kept track of using a matrix with components of spacetime to create a useful mathematical model. This is a complicated concept that requires hours of mathematical description and special relativity expressions. To keep the idea simple, we will focus on the individual photons for now. This paper will focus on a single photon model with the rotating positive and negative fields pointing in opposite directions.

When there are many photons propagating together (e.g. higher intensity light), they are observed in the form a wave like phenomenon (peaks and valleys) that describe the geometric expressions of the electric and magnetic fields. Specifically, this is a transverse wave phenomenon. Transverse waves have a spacial effect perpendicular to the direction of propagation. The electric field is perpendicular to propagation on one plane and the magnetic field is perpendicular to both the propagation and electric field (also right angle to the electric field). A moving electric field creates a magnetic field but conversely, a moving magnetic field can create an electric current (moving charges). To maintain consistency, we will hold the electric field as the fundamental effect on space and the magnetic field as the resultant effect because it is useful to do so. This is also convenient when we model particles, because the electric charge remains after particle creation and the opposing magnetic fields join to offset each other. However, a theory could possible be described with the magnetic field as the fundamental portion and consider them interchangeable depending on the relative coordinate system chosen.

Looking again at a single photon, the fields would be perpendicular to its curvature. If the photon has a spinning component of movement (angular momentum) and a straight line axis of movement (v=c), then a candidate for the description of motion would be a spiral helix type of propagation along a line as shown in figure 1.2.[5]

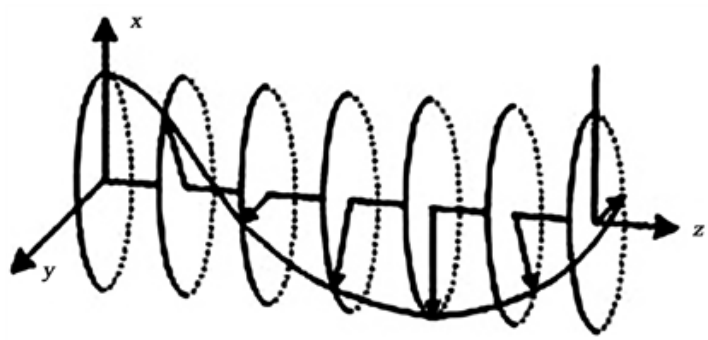


Figure 1.2

The photon is modeled as a one dimensional string or loop in a spiral configuration. This is an approximation as the wave is considered the underlying structure. As we progress to determining the structure of particles, this spiral motion and structure makes more sense. Exponential functions with this rotating feature are common place in the wave function descriptions used in the quantum physics of the Standard Model. The spiral motion is also useful in visualizing the geometries of the photon when it collapses into an orbit around itself, creates a closed curvature, and appears to be a particle.

If we look at electromagnetic radiation in its multiple photons/wave structure, this in phase structure is a like a sine wave when observed, as discussed previously. These wave motions were described by James Clerk Maxwell's popular equations that unified the electric and magnetic forces of nature. The equations are most easily visually described by a straight line polarized wave with non spinning perpendicular electric and magnetic fields as shown in figure 1.3. Electric fields require a charge source and this paper proposes that photons contain a charge source that becomes well defined when forming a particle.

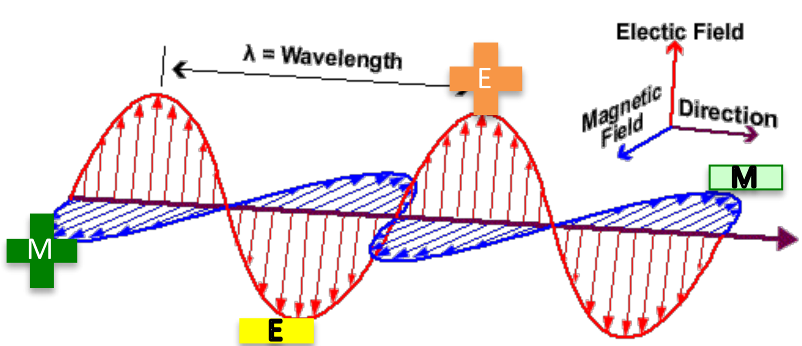


Figure 1.3

Electromagnetic waves are defined in nature by their wavelength. The shorter wavelength, the higher the energy. The longer the wavelength, the smaller the energy. Examples of very high energy electromagnetic radiation are gamma rays. Very low energy electromagnetic radiation are radio waves. Visible light is about in the middle of the electromagnetic spectrum as shown in figure 1.4.

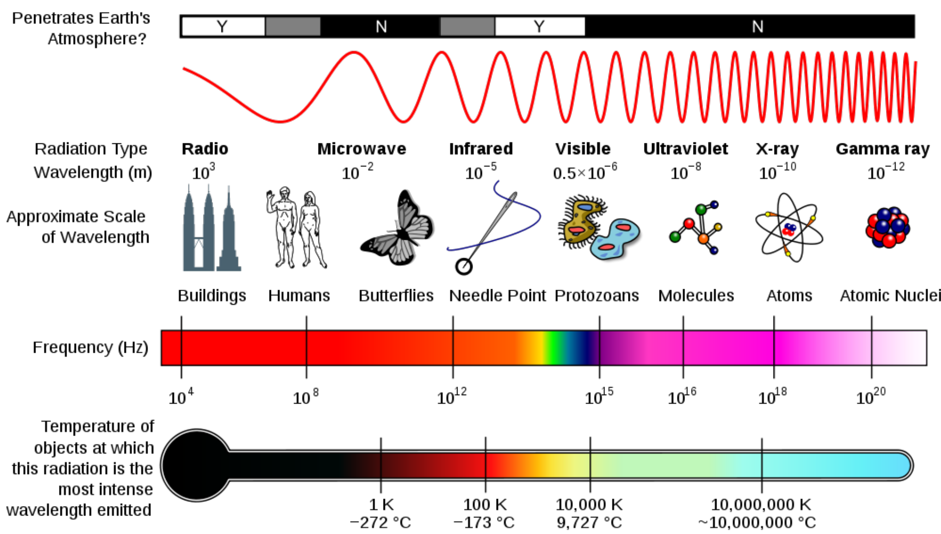


Figure 1.4

To reconcile this picture with the fundamental single rotating photon concept, a polarized ray of light would have to be modeled minimally as two photons that are exactly in phase (in the direction of propagation), but rotating radially in opposite directions. The positive fields will align at "12 o'clock" coinciding with the negative fields at "6 o'clock. The fields will be opposite and cancel each other at 3 o'clock and 9 o'clock respectively (the photons are traveling out of the paper towards the reader) as shown in figure 1.5.

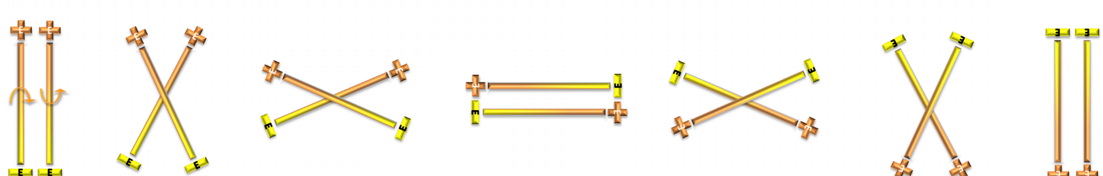


Figure 1.5

This means, passing through a polarizing light crystal that strips electric fields at perpendicular angles would have the effect only allowing multiples of a synchronized double photon system to pass through.

The typical description of circular light polarization usually involves building it from two linear polarized light waves traveling with their polarization fields 90 degrees from each other (at right angles). If one is out of phase by 1/4 of its wavelength, then the electrical fields will combine to form a rotating combined electrical field. Likewise, you could build a linearly polarized light wave from two circularly polarized light waves. Though this concept works with rays of light, it does not scale down to individual photon properties. Also, combining two perpendicular light waves out of phase, since the negative and positive polarization directions are opposite, you will end up mixing negative with positive fields and positive with negative fields. The result will end up being an interference effect and a less defined polarization direction. In this paper, and in quantum physics, the circularly polarized photon is fundamental and linear polarized light must be defined by combinations of photons as described above.

1.3 Photon as a combination of waves

Maxwell thought of space as an aether with substance where electromagnetic waves propagated. The current consensus is that all particles and forces interact through fields. Whether a photon interacts through a field, or is simply energy passing through the medium, the medium (or field) does not actually move substantially with the energy. Either way, it is most useful to think of the photon as as a thing moving with a speed, an idea that encompasses a model of energy in motion. This paper will use the moving photon convention (e. g. ocean wave) even if the only thing that moves is the energy but the propagation medium does not substantially move (e.g. ocean water). This theory will also attempt to show that photons act on space, curving it in different ways that can be also expressed as a field.

A method developed by Joseph Fourier will allow disturbances of any shape to be constructed using series of harmonic waves.[6] These disturbances will still themselves be solutions to the physics equations that describe waves. In other words, if the photon is a wave packet in space, then according to Fourier, this wave or wave packet or blip can be described as the sum of many continuous infinite sinusoidal waves (2 dimensional model) as in figure 1.6.

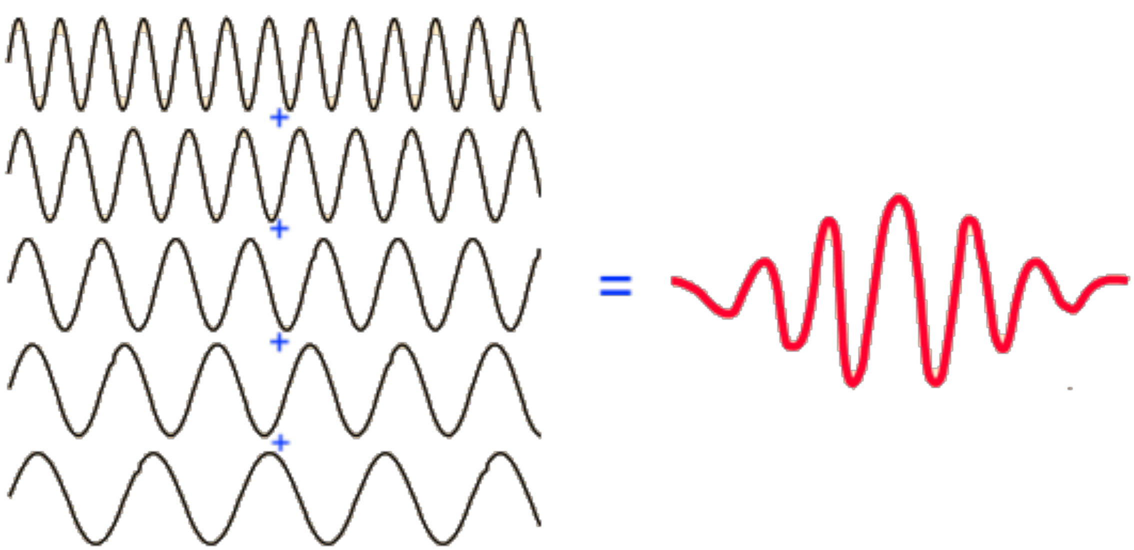


Figure 1.6

If we take this to be reality and model it in three dimensions, then it would mean every photon we observe are the combination of waves perturbing infinitely through the universe but creates a single local effect. Quite a concept that the infinitesimal may actually a representation of the infinite. This idea is very useful though, as it can explain wave particle duality of the photon. This also explains how any particle can be thought a disturbance of that particles field. Quantum Field Theory considers the field as fundamental and the particle is simply what is perceived when making an observation.[7] In this paper, we will focus on the localized photon convention, but consider each description interchangeable.

In fact, the double slit experiment could be explained by the Fourier representation. This experiment has confused the physics community as when light shined onto a surface with two small vertical slits, the pattern observed shinning through shows vertical bands of light and dark appearing that the waves have peaks and valleys - signs of wave interference. The same result happens (unexpectedly) when a photon is sent one at a time. When the positions are recorded each time a single photon is sent through, they still result in the build up of the same interference pattern. The photon appears to interfere with itself. Using electrons instead of photons also gives the same result, even one at a time. However, if the photons (and electron formed from photons) were actually a combination of infinite sinusoidal waves, the interference would actually be predicted whether the photons were sent all at once or one at a time. This could even considered as proof of a Fourier representation hypotheses.

Vacuum energy or zero point energy could also be explained in this manner. With an infinite undulation of sinusoidal energy waves, space would be full of energy although most if it in interference. The mechanism to pull particles from empty space would rely on removing the destructive interference to produce a local effect.

A second result of this would be the Casimir effect. This is the effect that when two conducting plates get close together, they have an attraction.[8] It is similar to the effect of two ships in the ocean that when are very close together, having a tendency to collide. The ocean waves colliding in between the ships gets smaller as the ships get closer. When the wave colliding force outside the perimeter surrounding both ships gets larger than the colliding force of the waves in between the ships, the net result is a closing force that pushes the ships together. With more infinite sinusoidal waves outside than in between two particle structures, the resulting force is a closing effect. The less the space for waves to push the structures apart, the resulting difference creates a net closing force on two structures very close together.

1.4 Definition of Mass

The photon is known to have momentum but no mass. How can this be when momentum is generalized as mass times velocity? The key here is curvature. Einstein’s theory of General Relativity describes gravity effects as a curvature in space. A particle with mass curves space and the curved space creates a path for the particle to move. As discussed previously, the photon's path is a helix style rotation around a direction of propagation. A single photon's curvature is described by its spin perpendicular to its axis of propagation. Since the structure of a photon is described in quantum physics as a "particle" of spin "1" and +/-h angular momentum, this means it will rotate one revolution per wavelength. A potential candidate for a physical description would be a symmetric photon with a length of one wavelength and a circumference of one wavelength. This means it's effective radius can be determined:

$$circumference = \lambda = 2\pi r_c$$

Solving for radius:

$$r_c = \frac{\lambda}{2\pi}$$

So now the photon has a propagation direction and physically defined radius. This radius is the curvature radius of the photon since it otherwise travels in a straight line.

Since all particles are made of photons, then the curvature has to be somehow conveyed by the structure and properties of the photon to calculate mass. Without redefining what mass is, whether a convention selection or simply a property of a particle made up of photons, the standard idea across classical and quantum physics is the consistency of momentum. This means momentum is a conserved quantity which does not change over time or the rate of change is zero or its derivative with respect to time is zero. As stated previously, it is well accepted that photons have momentum. The classical momentum of a photon (usually described with greek letter gamma) is defined specifically in physics and quantum mechanics as follows:

$$momentum_\gamma = p_\gamma = \frac{h}{\lambda}$$

Where h is Planck's constant and λ is the wavelength of the photon. By defining momentum as mass times velocity:

$$p = mv$$

We can derive a mass equation as:

$$m_\gamma = \frac{p}{v} = \frac{h}{\lambda v}$$

Where h is planks constant, λ is the wavelength of the photon and v is the velocity of the photon (typically the speed of light).

Following this path of logic, the mass can be expressed in terms of the curvature radius and the velocity of the photon along that curvature:

$$mass = m_\gamma = \frac{h}{\lambda v_c} = \frac{h}{2\pi r_c v_c} = \frac{\hbar}{r_c v_c}$$

Where ħ is the reduced planks constant (h divided by 2π) as stated before.

It would seem we just gave the photon "mass" and this goes against all widely accepted physics. Time to ball this paper up and throw it in the circular file cabinet.

Actually, older versions of this theory had me adamant that photons had measurable mass until the idea of open curvature came to me. (Great guns!) Since the curvature is geometrically a helix and effectively "open" (like a slinky), we will see that leads to the reason the photon appears to have no mass but still can have momentum. In fact, the mass would be just incredibly difficult to measure.

1.5 The Open Curvature of a Photon

Per the previous definition, mass is determined by a radius and velocity along that radius. The radius is linked to its wavelength. The higher the velocity along the radius, the less the mass, the slower the velocity, the larger the mass. Likewise, larger radius curvature leads to smaller mass and smaller curvature leads to more mass. It's like the slower and tighter turns you can make electromagnetic waves perform, the larger mass effect you have on space. This idea could even be linked to the Higgs mechanism that in Quantum Field Theory gives particles their mass. The slower the velocity along the curvature, the longer the opportunity for a potential interaction with a Higgs field and hence more the mass.

The other aspect of this mass formula would be the relative sign of the curvature a nearby particle experiences. If the curvature is turning away from a particle, this is defined as positive curvature (positive r_c) and results in a positive mass effect. If the curvature is turning towards a particle, this is defined as negative curvature (negative r_c), resulting in a negative mass effect. The photon's open curvature exposes its "insides" along a helical path. A stationary object will "feel" a positive radius while the photon's positive curvature rotation is on the near side of its propagation axis and negative radius when the photon's positive curvature rotation is on the far side of its propagation axis. This effect oscillating back and forth like a sinusoidal wave with a pulsing net radius and net mass. This is a similar effect to charge, where a stationary object feels the negative charge and then positive charge as the photon passes by with a net zero charge. And of course, the same concept can be applied to the magnetic fields.

The revelation of this idea is photons can have mass but almost in an oscillating form similar to electric charge and magnetic fields. Depending on a relative position of an object, it will "feel" positive and negative mass values of the photon as it passes by. The mass is somewhat directional and would be very difficult to measure. The overall curvature radius reveals a positive mass value which conveys to momentum. Relative mass is elusive. You would have to surround or engulf the photon completely to feel its mass. Conversely, as the photons travel away from you, the curvature pulse would dissipate, but as it moved towards you, the curvature pulse would increase. Total pulse net effect is a positive total curvature. Conversely, the engulfing view of the electrical charge and magnetic field net effect remains at zero. It is common to refer the photon as having no charge. It is more complete to say the photon has no "net" charge.

A ring particle created from orbiting photons will have its propagation direction converted from a straight line to an orbital motion. Now the curvature becomes "closed" completely. The overall average curvature of the ring is positive to relative particles since the inside is completely encircled by the positive curvature. This results in a net positive mass. No more negative curvature can be experienced by a relative object. It would be shielded on the inside of the particle. The mass effect now presents itself in full to interact with other relative particles. (Great guns!)

Since the photon has an open curvature, the bending of space would appear as extra mass but only on engulfing scales, for example, galactic scales. The traveling curvature of light as it, on average, travels from the center of the galaxy to the outer edge of the galaxy, would be of the structure of a halo with many tiny photon curvatures, expanding towards the edge of the galaxy. One might infer, this extra curvature could be responsible for the extra mass required to explain the velocity discrepancy of the stars in the galaxy. However, galaxies are mainly matter dominated and the contribution from light would be extremely small on the order of 6x10-5.[9] Therefore, the search for dark matter is to be continued.

Appendix A - Derivation of Photon Equations

A.1 Summary of equations

Photon Equations	
Mass	$m = \frac{\hbar}{r_c v_c} = \frac{h}{\lambda c}$
Kinetic Energy	$KE = \frac{\hbar \dot{z}^2}{2 r_c^2 \dot{\theta}} + \frac{\hbar \dot{\theta}}{2}$
Potential Energy	$PE = -\frac{\hbar \dot{z}^2}{2 r_c^2 \dot{\theta}} - \frac{3\hbar \dot{\theta}}{2} + \frac{\hbar \dot{z}}{r_c}$
Lagrangian	$\mathscr{L} = \frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}$
Momentum$_z$	$\Pi_z = \frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} - \frac{\hbar}{r_c}$
Force$_z$	$F_z = 0$
Momentum$_\theta$	$\Pi_\theta = -\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}^2} + 2\hbar$
Force$_\theta$	$F_\theta = 0$
Momentum$_r$	$\Pi_r = 0$
Force$_r$	$F_r = -\frac{2\hbar \dot{z}^2}{r_c^3 \dot{\theta}} + \frac{\hbar \dot{z}}{r_c^2}$

Table 1.1

A.2 Defining Energy

A deterministic explanation requires a mathematical representation of the model to make predictions that can be tested. Typically the process involves attempts to disprove a theory. When accumulated attempts to disprove the theory have not been successful, consensus begins to form in the scientific community.

The first step according to consensus in the physics community, is to develop a Lagrangian formula for the theory. The Lagrangian is a formulation of the difference between the kinetic energy and the potential energy of a system. Nature reveals the tendency of this difference to be minimized.

Particles tend to move to lower energy states, but the real concept behind all of quantum and classical physics is the balance of kinetic energy and potential energy. This balance is like a ball rolling down the side of a hill. The ball on top of the hill, high up, has a large potential energy. The ball is put into motion, gains speed down the hill and its kinetic energy gets larger as the potential energy gets smaller. The lower the height, the less the potential to roll farther. When the ball gets to the bottom, it can go no lower so its potential energy is at the lowest point. However, its velocity is at it highest and so is the kinetic energy. As the ball comes out of the valley and goes up another hill, the opposite occurs. The velocity slows and along with its kinetic energy but as its height increases, the potential energy also increases. This balancing act of energy in different forms encompasses the nature of physics. Energy shifts forms but is always conserved (stays constant). The mathematical description of a conserved quality (quantity that stays constant) is that is does not change with time. Another way to say this is that its time derivative of this quantity is zero.

The generalization of this concept is called the principle of least action.

Lagrangian formulations and the principle of least action are quite complex concepts to absorb, so I would advise a bit of research on these two topics (if not familiar) before digesting this section of the paper. These principles are extremely powerful, because physicists in the past have built a mathematical technique, using calculus, to take the derivatives of the Lagrangian to determine force components, momentum components and building the laws of motion from scratch. Even Einstein's equations, Maxwells equations, Newtons equations all simply reveal themselves surprisingly from this principle. Although these derivations were performed long after the original development of their theories, they provide a reinforcement that the fundamental physics are most likely valid. In fact, if a theory of everything or grand unified theory that was not derived from this principle, it would have a difficult time in the physics community to be pulled out from under the label of “pseudoscience”.

The overview is that the Lagrangian is the KE (kinetic energy) minus the PE 9potential energy). Using a classical familiar energy equation, we can state the kinetic energy in two components - the straight line KE and the rotational KE. The classical formulation would be:

$$\text{Kinetic Energy} = KE = \frac{1}{2}mv_z^2 + \frac{1}{2}mv_o^2$$

Where m is the mass of the photon, v_z is the velocity in the propagation direction and v_o is the orbital velocity. Even though the photon is considered massless, the mass solved from the momentum equation persists. This mass term has a classical linear and rotational part. Even if the mass is spread out in some form, the average total will orbit along an average radius as it propagates. As discussed previously, the photon path along a one dimensional line is the best candidate to model the mass orbit path even if it is an average.

Note, we have not included the energy from the electric fields. This would add additional terms in the kinetic energy equation, but they will have opposite signs and end up canceling each other out. For simplicity, we will ignore these terms for now, but realize that energy terns that cancel each other do not destroy energy. It simply exists in destructive interference or canceling terms.

Substituting the mass equation from above, we get:

$$KE = \frac{1}{2}\frac{h}{\lambda c}v_z^2 + \frac{1}{2}\frac{h}{\lambda c}v_o^2$$

$$KE = \frac{h\dot{z}^2}{2\lambda c} + \frac{hv_c^2}{2\lambda c}$$

Where λ is the wavelength of the photon and v_c. is the velocity of the photon along the curvature.

Substituting all velocities as the speed of light, c, we get:

$$KE = \frac{1}{2}\frac{h}{\lambda}c + \frac{1}{2}\frac{h}{\lambda}c = \frac{1}{2}\frac{hc}{\lambda} + \frac{1}{2}\frac{hc}{\lambda} = \frac{hc}{\lambda}$$

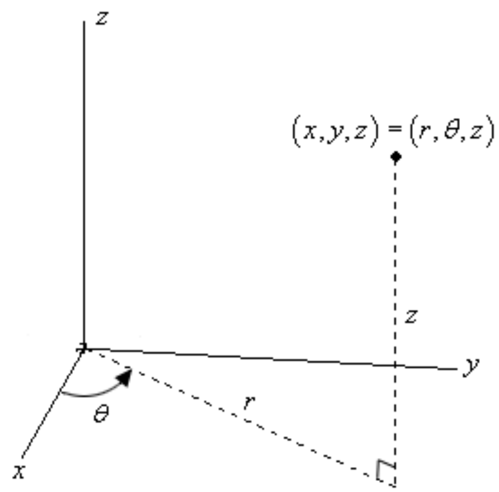
Since the frequency, f, is speed divided by wavelength (c/λ), what is revealed here is the photon energy equation:

$KE = hf$ or the more familiar form $E = hf$ and sometimes $E = h\nu$

This is Planck's equation or sometimes called the Planck–Einstein relation. So emerging from this logic, the energy of a photon widely accepted in physics as we know it, is also an expression of the Kinetic Energy portion of the total energy. To determine any potential energy component, we will have to construct the Lagrangian and follow the principle of least action rules that derive equations of motion.

A.3 Constructing the Lagrangian

If we take the central force problem (the center of the photon as "zero" of all coordinates) it can simplify the equation structure with a different coordinate system for the Langragian. We will use cylindrical coordinates in the form of r, θ, and z instead of the standard x,y,z because it is particularly useful:



The kinetic energy formulas previously had the form:

$$KE = \frac{h\dot{z}^2}{2\lambda c} + \frac{hv_c^2}{2\lambda c}$$

So there are (3) potentially different velocities; the straight-line velocity in the z direction, the orbital velocity around the circumference of the photon (curvature velocity that contributes to its mass/momentum), and the velocity in the radial direction which we will assume to be zero for now.

Rewriting in terms of angular velocity, in the new coordinate system, the curvature velocity is the same as the orbital velocity:

$$v_c = v_o = r_c\dot{\theta}$$

Where theta with a dot over it is the angular velocity of the photon (also the derivative of the angle with respect to time). Multiplying this by the radius of the photon gives the orbital velocity (velocity tangential to the radius).

If we also use the same dot notation with the velocity in the z direction (the derivative of z with respect to time) the expression will have the form:

$$KE = \frac{h\dot{z}^2}{4\pi r_c c} + \frac{h r_c^2 \dot{\theta}^2}{4\pi r_c c}$$

Since the orbital velocity can be expressed as a function of angular velocity:

$$KE = \frac{h\dot{z}^2}{4\pi r_c r_c \dot{\theta}} + \frac{h r_c^2 \dot{\theta}^2}{4\pi r_c r_c \dot{\theta}}$$

$$KE = \frac{\hbar\dot{z}^2}{2r_c^2\dot{\theta}} + \frac{\hbar\dot{\theta}}{2}$$

Which reveals a second term that may be familiar - the harmonic oscillator.

To construct the Lagrangian (difference between kinetic energy and potential energy), it will take the form:

$$\text{Lagrangian} = \mathscr{L} = KE - PE$$

Based on our coordinate system, we have to determine what coordinates the potential energy is dependent on. Typically, in a central force problem, the potential energy is only a function of r. Since we attempting to describe magnetic and electric forces with gravitational, the velocities are relevant in these interactions. Therefore we will assume contributions to the r and theta coordinate are possible and the z coordinate does not contribute to potential energies. The Lagrangian takes on this formulation:

$$\mathscr{L} = \frac{\hbar\dot{z}^2}{2r_c^2\dot{\theta}} + \frac{\hbar\dot{\theta}}{2} - PE(r,\theta)$$

The next speculation would be that of the potential energy. Based on previous iterations of the Lagrangian process, the potential energy is selected as follows:

$$PE(z,\theta,r) = -\frac{\hbar\dot{z}^2}{2r_c^2\dot{\theta}} - \frac{3\hbar\dot{\theta}}{2} + \frac{\hbar\dot{z}}{r_c}$$

The Lagrangian becomes:

$$\mathscr{L} = \frac{\hbar\dot{z}^2}{2r_c^2\dot{\theta}} + \frac{\hbar\dot{\theta}}{2} - \left(-\frac{\hbar\dot{z}^2}{2r_c^2\dot{\theta}} - \frac{3\hbar\dot{\theta}}{2} + \frac{\hbar\dot{z}}{r_c}\right)$$

$$\mathscr{L} = \frac{\hbar \dot{z}^2}{2r_c^2\dot{\theta}} + \frac{\hbar\dot{\theta}}{2} + \frac{\hbar \dot{z}^2}{2r_c^2\dot{\theta}} + \frac{3\hbar\dot{\theta}}{2} - \frac{\hbar\dot{z}}{r_c}$$

$$\mathscr{L} = \frac{\hbar \dot{z}^2}{r_c^2\dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar\dot{z}}{r_c}$$

A.4 Rules for Euler-Lagrange Equations of Motion

The rules of the principle of least action follows this process:

1. Pick a coordinate axis (e.g. z)
2. Take the derivative of the Lagrangian with respect to velocity along that axis (e.g. the derivative of L with respect to z dot). This is a general form of momentum also called the conical momentum equation.
3. Take the derivative of the Lagrangian with respect to the axis coordinate (e.g. the derivative of L with respect to z). This is the general force equation.
4. Take the derivative of the equation from step 2 with respect to time (e.g. the derivative of the conical momentum with respect to time). This usually represents mass times acceleration.
5. Set equation from step 3 equal to the equation from step 4 and you have (1) equation of motion.
6. Repeat for the rest of the axis coordinates and you have all equations of motion or have reached an interesting result.

Just for clarity, when we take the derivative, it is either the partial derivative or the total derivative. The partial derivative is when we hold all the other axis coordinate constant and take the derivative with respect to one coordinate. The time derivative is the total derivative rate of change of all coordinates with respect to time. Just for simplicity, we will use the partial derivative notation for all formulas.

The result of this process produces what is called the Euler-Lagrange equations of motion for each coordinate axis.

A.5 Deriving Equations of Motion for the z axis

The mathematical representation for coordinate axis z rules are:

$$\frac{\partial \mathscr{L}}{\partial z} = \frac{\partial}{\partial t}\left(\frac{\partial \mathscr{L}}{\partial \dot{z}}\right)$$

Deriving the formulas and assuming that potential energy is not dependent on z velocity:

$$Momentum_z = \frac{\partial}{\partial \dot{z}}\left(\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}\right)$$

$$Momentum_z = \frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} + 0 - \frac{\hbar}{r_c}$$

$$Momentum_z = \frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} - \frac{\hbar}{r_c}$$

If the velocities are set to c then:

$$Momentum_z = \frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} - \frac{\hbar}{r_c} = \frac{2\hbar c}{r_c c} - \frac{\hbar}{r_c} = \frac{2\hbar}{r_c} - \frac{\hbar}{r_c} = \frac{\hbar}{r_c}$$

$$Momentum_z = \frac{\hbar}{r_c} = \frac{h}{2\pi r_c}$$

$$Momentum_z = \frac{h}{\lambda}$$

Which is exactly the value generally accepted in physics.[10] It looks like we made the proper assumption that potential energy so far. The complete momentum equation is:

$$Momentum_z = \frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} - \frac{\hbar}{r_c}$$

The next step is to take the derivative of the Lagrangian with respect z which is commonly referred to as the force in that direction:

$$\frac{\partial \mathcal{L}}{\partial z} = Force_z = \frac{\partial}{\partial z}\left(\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}\right)$$

Since there is no term as a function of z (only z dot):

$$\frac{\partial \mathcal{L}}{\partial z} = 0 + 0 - 0 = 0$$

Setting the force term equal to the derivative of the momentum term:

$$Force_z = \frac{\partial}{\partial t} Momentum = \frac{\partial}{\partial t}\left(\frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} - \frac{\hbar}{r_c}\right) = 0$$

What this reveals is that the momentum in the z direction does not change with time (it is conserved). This means:

$$Momentum_z = \frac{2\hbar \dot{z}}{r_c^2 \dot{\theta}} - \frac{\hbar}{r_c} = Constant$$

A.6 Deriving Equations of Motion for the Theta coordinate

Equations of motion for theta:

$$\frac{\partial \mathscr{L}}{\partial \theta} = \frac{\partial}{\partial t}\left(\frac{\partial \mathscr{L}}{\partial \dot{\theta}}\right)$$

$$Momentum_\theta = \frac{\partial \mathscr{L}}{\partial \dot{\theta}} = \frac{\partial}{\partial \dot{\theta}}\left(\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}\right)$$

$$Momentum_\theta = \frac{-\hbar \dot{z}^2}{r_c^2 \dot{\theta}^2} + 2\hbar - 0$$

$$Momentum_\theta = -\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}^2} + 2\hbar$$

Setting the velocities equal to c gives:

$$Momentum_\theta = \frac{-\hbar c^2}{c^2} + 2\hbar = -\hbar + 2\hbar$$

$$Momentum_\theta = \hbar$$

Which is exactly the accepted value in physics.[3] Note, this could be a negative value depending on the convention selected. Still, so far so good. Looking at the force term for theta:

$$\frac{\partial \mathscr{L}}{\partial \theta} = Force_\theta = \frac{\partial}{\partial \theta}\left(\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}\right)$$

$$Force_\theta = 0 + 0 - 0 = 0$$

This also means the time derivative of the that a momentum is conserved (does not change with time.

$$Momentum_\theta = -\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}^2} + 2\hbar = Constant$$

A.7 Deriving Equations of Motion for the r coordinate

Now for the final coordinate axis, r:

$$\frac{\partial \mathscr{L}}{\partial r} = \frac{\partial}{\partial t}\left(\frac{\partial \mathscr{L}}{\partial \dot{r}}\right)$$

Substituting the formulas:

$$Momentum_r = \frac{\partial \mathscr{L}}{\partial \dot{r}} = \frac{\partial}{\partial \dot{r}}\left(\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}\right)$$

$$Momentum_r = \frac{\partial \mathscr{L}}{\partial \dot{r}} = 0 + 0 - 0$$

$$Momentum_r = 0$$

The net momentum in the r coordinate is zero.

Taking the derivative of the Lagrangian with respect to r:

$$\frac{\partial \mathscr{L}}{\partial r} = Force_r = \frac{\partial}{\partial r}\left(\frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}\right)$$

$$\frac{\partial \mathscr{L}}{\partial r} = Force_r = \frac{-2\hbar \dot{z}^2}{r_c^3 \dot{\theta}} + 0 - \frac{-\hbar \dot{z}}{r_c^2}$$

$$\frac{\partial \mathscr{L}}{\partial r} = Force_r = -\frac{2\hbar \dot{z}^2}{r_c^3 \dot{\theta}} + \frac{\hbar \dot{z}}{r_c^2}$$

$$Force_r = -\frac{2\hbar \dot{z}^2}{r_c^3 \dot{\theta}} + \frac{\hbar \dot{z}}{r_c^2}$$

Setting the velocities equal to c :

$$Force_r = -\frac{2\hbar c^2}{r_c^2 c} + \frac{\hbar c}{r_c^2}$$

$$Force_r = -\frac{2\hbar c}{r_c^2} + \frac{\hbar c}{r_c^2}$$

$$Force_r = -\frac{\hbar c}{r_c^2}$$

We can rewrite in terms of the mass term where:

$$mass = \frac{\hbar}{v_c r_c} = \frac{\hbar}{c r_c}$$

The force term can be rewritten as:

$$Force_r = -\frac{\hbar}{c r_c}\frac{cc}{r_c}$$

$$Force_r = -\frac{\hbar}{c r_c}\frac{c^2}{r_c}$$

$$Force_r = -m\frac{c^2}{r_c}$$

$$Acceleration_r = -\frac{c^2}{r_c}$$

Which is the familiar acceleration formula for the centrifugal/centripetal force of a ring orbital. The r coordinate result also has a classical deterministic interpretation.

A.8 The Semi Complete Lagrangian

$$\mathscr{L} = \frac{\hbar \dot{z}^2}{r_c^2 \dot{\theta}} + 2\hbar\dot{\theta} - \frac{\hbar \dot{z}}{r_c}$$

Note, I refer to this as the semi complete Lagrangian because there are terms missing related to the kinetic energy of the electric charge. Since these terms point along the radius axis in opposite directions they would seem to cancel each other out. When photons collapse into a particle, the alignments of charge will change so the kinetic energy of the charge becomes very relevant.

A.9 References

1. Czarnecki, Andrzej; Karshenboim, Savely G. (2000). "Decays of Positronium". In Levchenko, B. B.; Savrin, V. I. (eds.). Proceedings of the International Workshop on High Energy Physics and Quantum Field Theory (QFTHEP). Vol. 14. pp. 538–544. arXiv:hep-ph/9911410. Bibcode:1999hep.ph…11410C.
2. Einstein, Albert (1917). Über die spezielle und die allgemeine Relativitätstheorie : (Gemeinverständlich) (Erstaufl. ed.). Braunschweig: Vieweg. Retrieved July 5, 2016 – via ECHO – Cultural Heritage Online - Max Planck Institute for the History of Science, Library
3. Beth, R.A. (1935). "Direct detection of the angular momentum of light". Phys. Rev. 48 (5): 471. Bibcode:1935PhRv...48..471B. doi:10.1103/PhysRev.48.471.
4. "The Nobel Prize in Physics 1921". Nobel Prize. Archived from the original on 3 July 2018.
5. Cheng, J. (2019) Hypothesis about the Motion of Photon in the Space. Open Access Library Journal, 6, 1-9. doi: 10.4236/oalib.1105907.
6. Lejeune-Dirichlet, Peter Gustav (1829). "Sur la convergence des séries trigonométriques qui servent à représenter une fonction arbitraire entre des limites données" [On the convergence of trigonometric series which serve to represent an arbitrary function between two given limits]. Journal für die reine und angewandte Mathematik (in French). 4: 157–169. arXiv:0806.1294.
7. Shifman, M. (2012). Advanced Topics in Quantum Field Theory. Cambridge University Press. ISBN 978-0-521-19084-8.
8. Casimir, H. B. G. (1948). "On the attraction between two perfectly conducting plates" (PDF). Proc. Kon. Ned. Akad. Wet. 51: 793
9. Unsöld, A.; Bodo, B. (2002). The New Cosmos, An Introduction to Astronomy and Astrophysics (5th ed.). Springer-Verlag. p. 485. Bibcode:2001ncia.book.....U. ISBN 978-3-540-67877-9.
10. Einstein, A. (1917). Zur Quantentheorie der Strahlung, Physicalische Zeitschrift 18: 121–128. Translated in ter Haar, D. (1967). The Old Quantum Theory. Pergamon Press. pp. 167–183. LCCN 66029628.