# Quantization and Relativity

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## Abstract

Scientific inquiry is a pursuit to answer a set of basic questions. Cause, is one of the most fundamental of those questions. An important aspect of science is the ability to discover cause, and then to discover, and clearly show, the relationships which constitute that cause.

Due to the fundamental scientific premise to show cause, we will present an interpretation of the behavior of space to the presence of fundamental energy. In this process we come to understand some the properties of space in more significant detail. As a consequence, we will also, quite interestingly, also be able to *show cause for electric charge, magnetic fields, the strong force, quantization, momentum, mass, entanglement, what have been called "pilot waves", and the transformations which cause relativity.*

The initial intent in this research was just to understand electric charge and the constitution of the electron. But as researched progressed, and possible mechanisms for the creation of charge were examined, many aspects of our physical universe became clearer and more easily definable.

*"It is my opinion that everything must be based on a simple idea. And it is my opinion that this idea, once we have finally discovered it, will be so compelling, so beautiful, that we will say to one another, yes, how could it have been any different."—John Archibald Wheeler*

## Introduction

The nature of space itself is an intriguing question. As Einstein pointed out, "*There Is an Important argument In favor of the hypothesis of the ether. To deny the existence of the ether means, in the last analysis, denying all physical properties to empty space*"… and when he said, "*the ether remains still absolute because its influence on the inertia of bodies and on the propagation of light is conceived as independent of every kind of physical influence.*"

These observations by Einstein occurred much later in his career than his suggestion in his 1905 paper "*The Electrodynamics of Moving Bodies*", where he had proposed that space could be empty and just a void. So during his life of research Einstein returned to the conclusion that the "ether" exists and that space is not just a vacuum. Given his research into General Relativity and many other aspects of physics, subsequent to his proposal for Special Relativity, he had returned to the notion of an "ether", and believed firmly in its existence, as evidenced by his statements above.
Einstein was, of course, not the only noteworthy physicist to come to these conclusions.

Earlier, circa 1865, James Clerk Maxwell's work had disclosed that the behavior of propagating electromagnetic energy performs in very many ways analogous to transverse waves in an elastic solid. Which is yet another clue that space may at least consist some sort of special qualified medium through which displacements propagate in some form. This concept that space consisted of a Euclidian three dimensional medium, a fixed frame, seemed to be the driving idea behind the transformations proposed by Lorentz for material objects moving through space. Those transformations attributed to Lorentz were derived directly from the Pythagorean Theorem, which is *a fundamental relation in Euclidian Geometry*.

It is therefore a reasonable idea to explore the concept that space may be some form of specialized medium. Historically the word "ether" has often been used to convey the concept of space as a completely unique medium.

As you will discover in the discussion which follows, exploring various concepts that space may be some form of specialized medium, while considering the body of experimental evidence, produces a host of remarkable results.

John Stewart Bell provided physics with some remarkable and valuable insight. Part of what Bell discovered has been widely discussed and applauded. But he learned more, and tried to share more, than we currently give him credit for. During his research, studied relativity and quantum mechanics, both in some depth. He provided valuable insight into aspects of the nature of particles which were contrary to the EPR premise. He came to understand the nature of the some of the potential errors in our theories. As a result of that effort he said: *"I would say that the cheapest resolution is something like going back to relativity as it was before Einstein, when people like Lorentz and Poincar´e thought that there was an aether – a preferred frame of reference – but that our measuring instruments were distorted by motion in such a way that we could not detect motion through the aether. Now, in that way you can imagine that there is a preferred frame of reference, and in this preferred frame of reference (some) things do go faster than light."…" Behind the apparent Lorentz invariance of the phenomena, there is a deeper level which is not Lorentz invariant, a pre-Einstein position of Lorentz and Poincar´e, Larmor and Fitzgerald, was perfectly coherent, and is not inconsistent with relativity theory. The idea that there is an aether, and these Fitzgerald contractions and Larmor dilations occur, and that as a result the instruments do not detect motion through the aether – that is a perfectly coherent point of view."— John Stewart Bell.*

What Bell was attempting to do is to show us a way we can reconcile "relativity" theory and quantum mechanics.

We will show a new approach, a new interpretation of the data, which both achieves John Archibald Wheeler's vision, and agrees with John Stewart Bell's conclusions. This is a causal quantum theory which also demonstrates cause for the relativity we encounter when studying the universe.

## Mechanics of Displacement and Waves

In engineering, the studies of stress, strain, displacement, and wave propagation, in various media, has yielded a quite precise and functional description. We have come to understand how the tensors, forces, mass density, and structure of a media, affect displacement and wave propagation. That information is useful in this context, for it is tested and proven, and gives us scientific guidance in our analysis of space as some special and quite unique medium.

To summarize aspects of what we know about displacements and waves in media we can make a list of observed behavior.

1. All media support some form of longitudinal displacement.
2. In some media transverse waves are supported and can propagate.
    a. Transverse wave propagation is at a fixed velocity under uniform circumstances.
    b. In general, the frequency range for transverse waves in a specific medium is limited.
3. Not all media support transverse waves.

The speed of longitudinal displacement in a medium is defined as:

$$v = \sqrt{\frac{K + \frac{4}{3}\mu}{p}}$$

The speed of transverse wave propagation in a medium is defined as:

$$v = \sqrt{\frac{\mu}{p}}$$

Where *v* is velocity, *K* is bulk (longitudinal) modulus, $\mu$ is shear modulus, and *p* is mass density.

Note that these equations require the speed of longitudinal displacement *must always be faster* than the speed of a transverse wave.

When we then turn our attention to the possible nature of space as a medium, we suggest that space has no perceptible inertial content, and therefore no mass density term. This of course makes space a very unique medium indeed. But it also introduces an issue which is important for our consideration. With no mass density term, no inertia, *space does not possess the properties required to support what we normally observe as transverse waves in a medium*. If space has no mass density term then space would have to be unlike a material medium but rather like a tension medium only. This is similar to saying that forces never *push* in space, and that all fundamental forces in space are pulling (tension) forces.

And if space is an inertia free medium, then what we perceive to be transverse waves in space are something more. That condition agrees, as we will show later, with the concept that light is quantized into "photons", and shows how electromagnetic radiation in the form of photons *can quite clearly produce the illusion of transverse waves in space*. Even though this set of conditions in space would make space much different than material media with which we are familiar, it is quite easy to reconcile

these behaviors and properties of space with what we observe in the action of electromagnetism and the properties of particles.

## Quantization of Energy and Charge

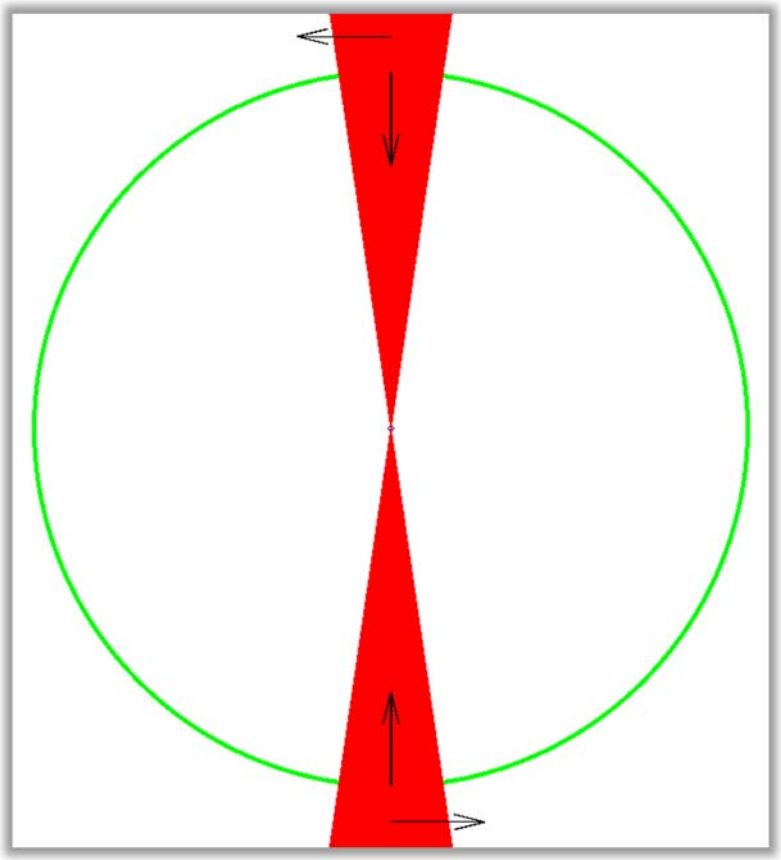
There are many observable aspects of quantization in the behavior of light and particles. The quantization of light and fermions implies that fundamental energy in space localizes itself. Planck's constant of action indicates that a photon with more energy has a smaller (higher frequency, shorter wavelength) oscillation than a particle with less energy. E=hv. Quantization of electric charge yields valuable information, as we will see, regarding the mechanism of quantization in general.

Interestingly, the type of tension medium we have begun discussing above, exhibits the explicit properties to cause exactly this quantization we see in nature. But perhaps somewhat surprisingly the displacement of space which causes quantization is not in the form of transverse waves in space.

Considering the physical evidence we observe, including Planck's constant of action, we can demonstrate a quantization mechanism which reacts precisely as we observe in nature. But that fairly simple quantization mechanism is quite different from, and more complete than what we have previously envisioned.

To be more specific, we now address the fundamentals of this form of displacement of space and quantization.

The energy of particles pulls space to displace space toward the particle center. But the properties of space and its reaction to this energy cause the displaced regions to be more localized into circulating strips of displacement, rather than spherical displacement toward the particle center. The reaction of space to energy also causes these longitudinal (toward the particle center) displacement regions to spin about the particle center. These conclusions have been proposed for some simple reasons, and we will describe those as we continue. While studying the nature of electric charge, it became apparent that this sort of displacement of space could cause exactly the effects we measure regarding the behavior of electric charge. And it was also immediately apparent that this set of conditions would create the precise forces of the magnetic field of the electron as well as the specific force of electric charge. The quantization of electric charge, the value of the elementary charge, was also a direct consequence of this configuration. So with one simple set of conditions, a deeper understanding of several aspects of the makeup and behavior of the electron were disclosed.

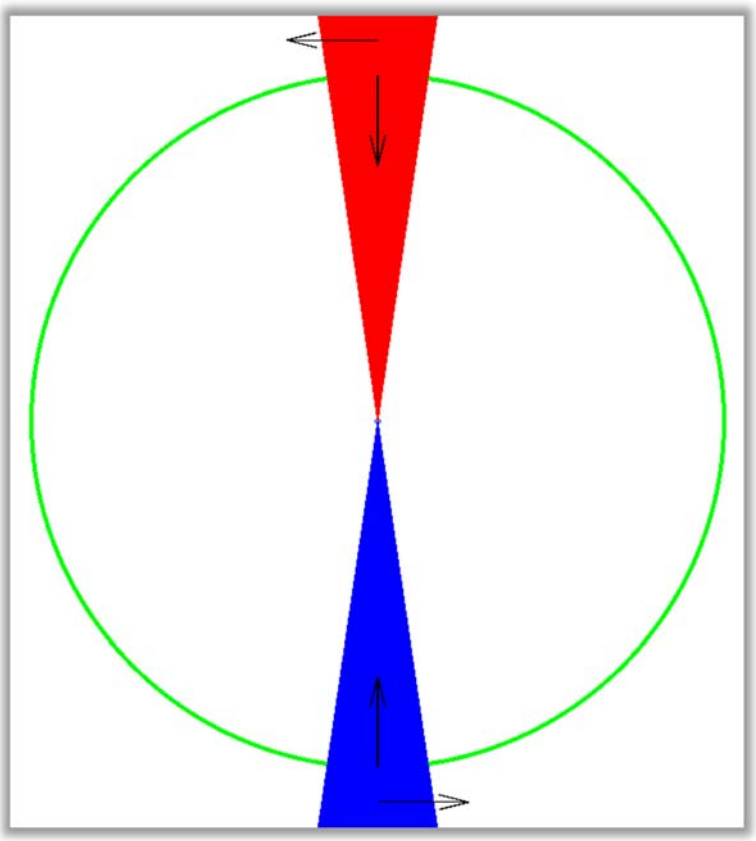


To illustrate this set of conditions in a simplified graphic cross-section, we will use the figure to the left. At the center of the particle is a tiny circle (almost invisible in this figure). Space is displaced longitudinally (red regions) toward the particle core (the tiny circle). And these displacements spin about the particle center (left and right black arrows at the top and bottom of the image). The green circle is the momentum radius if the particle, and we will describe that feature later in this document. The width (thickness) of the displacement regions is clearly defined by the nature of particles and charge, as we will show.

Quantization of energy occurs in space because the fundamental energy of particles is self-localizing. Energy pulls on space toward the particle center. The way a particle creates its momentum radius is an important aspect of our perception of this quantization, and we will discuss that mechanism later when we show cause for the creation of momentum by energy in space.

The creation of electric charge and the quantization of electric charge are functional and simple results of the displacement of space by energy in the manner we have been discussing.

In order for us to experience two polarities of electric charge, and in order for the positron to be the exact antiparticle of the electron, in the interpretation we have been discussing, there must be two components which exist in the tension medium of space. An elementary fermion displaces only one of these two components. So that in the illustration above, the red region is the displacement of the electron of one of the two components of space. This two component medium of space allows two polarities of charge to exist which are identical but “opposite”.



The photon displaces two components of space. Each component of space displaced by the photon is acted upon by half of the photon's energy. This difference in the electron and photon is the specific cause for the spin angular momentum of the photon being ħ, while the electron spin angular momentum is ½ ħ. We will show the mechanisms and mathematics for why this simple difference in spin angular momentum exists when we address momentum later in the discussion.

The fundamental energy which creates particles in this manner, reacts with space in an ordered and consistent manner. We can state in general terms that more energy pulls on space to displace space more, and that more energy also causes a faster spin rate of displacements created by that energy.

With the evidence available, we can define mathematically, the ordered and consistent manner in which this fundamental energy of particles reacts with the two component medium of space. Space itself is a regular Euclidian three dimensional space. Our perception of "relativity" and the causal basis for relativity, will be described, and mathematically defined, in later sections.

The force of this fundamental force of energy of particles, which causes the confinement force $F_c$ of the particle is:

$$F_c = \frac{\hbar\, c}{r^2}$$

Which holds for any distance from the particle, outside the particle core.

Not coincidentally the force $F_c$ we defined above is of the exact value of the strong nuclear force.

The force of electric charge between any two charged particles at any distance outside the particle core is:

$$F_e = \frac{\alpha\, \hbar\, c}{r^2} = \frac{e^2}{4\pi\, \varepsilon_0\, r^2}$$

$$\alpha\, \hbar\, c = \frac{e^2}{4\pi\, \varepsilon_0}$$

One important constant we will define is a term which describes a ratio of the square root of force of electric charge $F_e$ between two particles and the force of confinement $F_c$ we defined above.

$$\varrho = \frac{\sqrt{F_e}}{F_c} = 0.092762137717132$$

The total width (thickness) of the spinning displacements at any $r$ outside the particle core is:

$$d = 2\pi\, r\, \varrho$$

Electric charge is then, quite simply, the equal and opposite reaction of space to the mean force at that distance from a charged particle.

The rate of spin (tangential velocity) at the surface of the particle core is always $\sqrt{2}\ \alpha\ c$.

The radius $r_c$ of the particle core of an elementary fermion is always:

$$r_c = \frac{\frac{1}{2}\hbar\ \alpha\ c}{E}$$

The particle core is a region of uniformity where there is no gradient of space, and therefore a region of no charge or electromagnetic field. That core becomes smaller with energy, so that the total force at the particle core radius varies with energy because the core is smaller for a more energetic particle.

Space, as this unique two component tension medium, has a set of properties which provide causal mechanisms for what we are able to detect and observe in nature. One of the results of this set of properties is a velocity sensitivity related to the transverse motion of these spinning displacements. At the point on a spinning displacement where its transverse motion through space is $\sqrt{2}c$, the properties of space create an impulse force across the displacement. This impulse force is momentum. We will discuss the cause, and mathematically define this momentum later. But the result is that energy in space displays the property of momentum, and that there is a momentum radius, a radius of Planck Action, for each particle. The momentum radius of an elementary fermion is:

$$r_m = \frac{\frac{1}{2}\hbar\ c}{E}$$

The momentum radius of a photon is:

$$r_m = \frac{\hbar\ c}{E}$$

The photon radius is larger because ½ the energy of the photon is acting on each of the two components of space.

Of course we know that momentum tends to want to move in a straight line, and that deflecting momentum requires a force. As it turns out, the force $F_c$ we have been discussing is exactly the force required to confine the created momentum to this momentum radius.

Above we provided a cursory definition of the quantized way energy reacts with space in general terms. Now we will show these same principles as they relate to the momentum radius of an elementary fermion.

The force of energy of an elementary fermion at the momentum radius is:

$$F_c = E^2 C_F$$

The force of energy of a photon at the momentum radius is:

$$F_c = \left(\frac{E}{2}\right)^2 C_F$$

Where the constant $C_F = \frac{4}{\hbar c}$.

The total width of displacement at the momentum radius (Planck Action radius) of the spinning displacements constituting an elementary fermion at rest is:

$$d = \frac{d_w}{E}$$

Where the constant $d_w = \frac{h c \varrho}{2}$

So that at any radius outside the particle core:

$$d = 2\pi r \varrho$$

The time it takes the displacements to pass a point in space at the action radius of an elementary fermion at rest as the displacement spins is:

$$t = \frac{t_w}{E}$$

Where the constant $t_w = \frac{h \varrho}{2\sqrt{2}}$

The angular rate of spin, in radians per second, of an elementary fermion is:

$$w = \frac{2\sqrt{2}}{\hbar} E$$

The angular rate of spin, in radians per second, of a photon is:

$$w = \frac{E}{\hbar}$$

The frequency of circulation of an elementary fermion is:

$$f = \frac{2\sqrt{2} E}{h}$$

The frequency of circulation of a photon is:

$$f = \frac{E}{h}$$

In the brief summary above we have shown the principal mathematics which provide the source, the cause, of quantization of energy, mass, light, and electric charge.

## Momentum in Space

The properties of space which cause the things we observe, can be expressed in a simple and elegant model of space as a three dimensional Euclidian tension medium consisting of two components, and with the fundamental energy of particles pulling on space to cause spinning longitudinal displacements in the medium of space.

One aspect, of we observe, of this reaction of space to energy, is the presence of momentum created by these quantized energy structures. We detect momentum in two general forms, which are, longitudinal momentum, and spin angular momentum. By understanding spin angular momentum we can come to more fully understand the mechanisms in space which cause all forms of momentum we can measure.

Momentum is an impulse type of force. Meaning that it is a specific force for a specific amount of time.

We have been discussing the forces of fundamental energy which causes energy to be quantized in space. And we have reviewed some of the properties which would have to exist in the reaction of space to energy, for us to detect and observe what we see in nature. The simplified analysis of spin angular momentum teaches that momentum must exist external to the center of an object, for the rotation of that momentum to be presented as spin angular momentum. Meaning that there must be a momentum extent, a rotational momentum radius, for an object to exhibit spin angular momentum. In simple terms this means that describing the electron as a point is an incomplete description, and that the electron must possess a momentum radius in order to exhibit spin angular momentum. Of course the same argument generally persists in relation to the photon, which also exhibits spin angular momentum.

A simple solution to the issue of the creation of momentum by energy in space, based on the body of experimental evidence we have regarding momentum of particles, can be described as follows:

The properties of the tension medium of space only allow the creation of the impulse force of momentum at those points on longitudinal displacements which are moving transversely through space at the velocity $\sqrt{2}\,c$.

Expressing that impulse force of momentum mathematically, based on the displacements of space we have proposed, is not difficult.

Conventional momentum is expressed as:

$$p = mv$$

Momentum *p* in this equation, represents the inertial force that is exerted by mass *m* at velocity *v*.

Since momentum is generally expressed as a mass at a velocity, and velocity is distance divided by time, then the following would also be true:

$$p = m\frac{d}{t}$$

So, we can write:

$$p = F\frac{d}{t} = \frac{F\ d}{t}$$

Momentum is the product of force and distance divided by time.

A difference in the force of space which opposes $F_c$ at the front and back (leading and trailing portions) of the transversely moving longitudinal displacement, can therefore cause the impulse force which is momentum. The total momentum $p_T$ of these transversely moving displacements within a particle can then be written as:

$$p_T = \frac{\Delta F_c\ d}{t}$$

Where the delta force $\Delta F_c$ is the difference in the force of space at the fore and aft portions of the displacement region, *d* is the distance across the displacement region, and *t* is the time it takes the displacement region to pass a point in space as it moves transversely.

## The Creation of Inertial Mass in Elementary Fermions

Due to the model we have presented for the reaction of space to energy there arises a quite fundamental way to derive the mass of the electron from the creation of confined circulating momentum.

Above we used a formula to represent the relationship between momentum and the delta force $\Delta F_c$ of space which causes momentum.

$$p_T = \frac{\Delta F_c\ d}{t}$$

Where $\Delta F_c$ is the difference in the opposing force of space at the fore and aft portions of the displacement region at the momentum radius of a particle, *d* is the distance across the displacement region, and *t* is the time it takes the displacement region to pass a point in space at the momentum radius, as the displacement spins.

If we rearrange this equation to solve for $\Delta F_c$ of the electron we obtain:

$$\Delta F_c = \frac{p_T\ t}{d}$$

Now let's work through that equation.

Momentum (total) $p_T$ of the electron at rest is:

$$p_T = \frac{E}{c^2}\sqrt{2}c = \sqrt{2}\frac{E}{c} = \frac{d\ E}{t\ c^2} = \frac{d_w}{t\ c^2} = 3.86211\text{E} - 22\ \text{kg} \cdot \text{m/s}$$

Distance *d* (thickness of displacement) is:

$$d = 2\pi\ r_e\ \varrho = 2\pi\ r_e\ 0.0927621 = \ 1.1253487399\text{E} - 13\ \text{m}$$

Time *t* (time required for the displacement to pass a point as it spins) is: $t = \frac{d}{\sqrt{2}c} = 2.6543087\text{E} - 22\ \text{S}$

Then when we insert the values for momentum *p*, time *t*, and distance *d*, we obtain:

$$\Delta F_c = \frac{p_T\ t}{d} = \frac{(3.86211\text{E} - 22)\ (2.654308687\text{E} - 22)}{1.1253487399\text{E} - 13} = 9.1093826\text{E} - 31\ \text{kg}$$

So that the delta force $\Delta F_c$ we have been discussing, is precisely the mass of the electron, when an elementary fermionic particle has the energy of the electron:

$$\Delta F_c = 9.1093826\text{E} - 31\ \text{kg} = \text{m}_e$$

Note that this distance (thickness of displacement) *d* and time *t* are required in order for the electric charge to be the value of the elementary charge, and for the momentum and mass to be correct. But with these values for distance (thickness of displacement) and time, all of these parameters: electric charge, momentum, spin angular momentum, and mass, are correct. We have with this, shown that there is a causal mass/energy ratio for an elementary fermion ($E=mc^2$), and specifically how energy creates mass.

Always for any elementary fermionic particle: $\Delta F_c = m = \frac{E}{c^2}$

And:

$$p_T = \frac{\Delta F_c\ d}{t}$$

The forward momentum component of a photon is then quite simply:

$$p = \frac{\Delta F_c\ d}{\sqrt{2}\ t} = \frac{E}{c}$$

In this manner we can describe both momentum and mass while simultaneously accommodating electric charge and magnetism. This clear and concise definition of mass with all the observed properties of particles is simple and elegant.

# The Rest Mass of the Electron

First we want to state, as many physicists have suspected, there is only one value for the energy of a stable elementary fermion at rest in space, which accommodates the properties of space precisely. That one specific value is the energy of the electron or positron at rest.

Using this model of space and its reaction to energy we can demonstrate the fixed parameters of space which dictate the mass and energy of the electron.

A first clue to these parameters arises when we review the important ratio ϱ we introduced earlier.

We introduced this ratio ϱ for several reasons, but to make a long story short, it is the key to understanding electric charge. We have been able to calculate the value of ϱ in many different ways, always yielding the same answer. One way to calculate ϱ is:

$$\varrho = \frac{\sqrt{F_e}}{F_c}$$

Since $F_e = \frac{\alpha\, \hbar\, c}{r^2}$ and $F_c = \frac{\hbar\, c}{r^2}$ the equation above holds for any elementary particle.

Another equation which yields the value of ϱ is:

$$\varrho = r_e \sqrt{\frac{\alpha}{\hbar\, c}}$$

But the electron and positron, at rest, are the only particles where this equation is true. Which indicates that there is something special and preferred about the momentum radius of these particles at rest, in relation to the reaction of space to energy.

We will be able to show more specific cause for this rest mass of the electron by better describing the action of the constants we introduced previously:

$$d_w = \frac{h\, c\, \varrho}{2} \; and \;\; t_w = \frac{h\, \varrho}{2\sqrt{2}}$$

When we move an elementary fermion in space we must add energy. The constants $d_w$ and $t_w$ when viewed from a fixed frame, are *fixed properties of space* related to any elementary fermion. And these constants are the cause for the mass of the electron at rest being 9.1093826E-31 Kg, and the energy of the electron at rest being 8.187104786845060E-14 J. Illustration and description of this premise follows.

Suppose an electron is moving at 0.866025403784439 c so that the Lorentz factor γ which relates to that motion through space is 2.0. The energy of that electron would be $E = \gamma\, E_0\; or\; 2E_0$. So the width of spinning displacement related to the frame of the moving electron would be:

$$d = \frac{d_w}{2E_0} = 5.62674369960186\mathrm{E} - 14\ \mathrm{m}$$

But the width of displacement, at the momentum radius, related to the fixed frame of space in which this electron is moving would be:

$$d = \gamma \frac{d_w}{2E_0} = 2 \frac{d_w}{2E_0} = 1.12534874\text{E} - 13 \text{ m}$$

And the width of displacement, at the momentum radius, of an electron at rest in space is:

$$d = \frac{d_w}{E_o} = 1.12534874\text{E} - 13 \text{ m}$$

Which indicates that there is only one value for the width of displacement at the momentum radius, viewed from the fixed frame of space, which is compatible with the properties of space. So that a time constant of space, coupled with the width of displacement at the momentum radius, viewed from the fixed frame of space, determines the energy and mass of the most stable elementary fermions, the electron and positron, whether these particles are at rest or are moving through space.

The electron and positron are ordered energy structures, bound by tremendous forces in relation to their mass. The laws which govern the organization of these energy structures forcibly require that the mechanisms and topology follow a specific organization. And the forces which dictate that organization are very large compared to any accelerating force we may apply to these particles, and compared to the mass of these particles. With this in mind it is much easier to see why we must add energy to move an electron in space. It is simply a causally describable requirement of space that a moving electron must have more energy than an electron at rest.

## Gravitational Mass and the Quantization of Gravity

In the section above on the creation of inertial mass in elementary fermions, we presented cause, and the mechanism by which inertial mass is created. Throughout this document we have shown how energy displaces space in a specific manner to create the particles of nature. An interesting side effect of what we have proposed is the natural occurrence of a gravitational interaction of masses.

Two aspects of gravity must be considered in order to complete this clear and concise picture of gravity. One aspect is the “gravitational field” which is created by these displacements we have been discussing. The other aspect is the force, the reaction of mass, to that gravitational field.

If there is a field gradient in space which causes a slight redirection of momentum within a particle, then the mechanism which creates inertial mass described above, is also the mechanism which creates the force of gravity within a mass located within that gravitational field. This simple premise demonstrates how it is that inertial mass and gravitational mass are equivalent. They are equivalent quite clearly because they are created by the same mechanism of confined momentum.

We can analyze the forces we have discussed and relate those forces to the force of gravity.

We have shown that the force of energy $F_c$ is quantized and that it can be represented by:

$$F_c = \frac{\hbar\, c}{r^2}$$

We have also shown that the force of electric charge $F_e$ is quantized and can be expressed as:

$$F_e = \frac{\alpha \, \hbar \, c}{r^2}$$

It is therefore reasonable to suggest that the *gravitational field intensity* is also quantized, and is caused by the same displacement of space which causes the other forces of nature.

The mechanism of action of the gravitational field is quite different from the mechanism of electric charge, in that the field gradient of gravity only acts in a way which slightly deflects the trajectory of the affected particle's confined momentum. Given the model of space and its reaction to energy proposed herein, the action of gravity is a natural expected consequence of that premise.

Let us use an example to illustrate the gravitational field created by the energy of elementary fermions in this model of space and its reaction to fundamental energy.

For this example, we will use the force of gravity between two electrons at a distance of 1 meter.

The standard Newtonian gravitational equation for this situation is:

$$F = G \, \frac{m_1 \, m_2}{r^2} = 6.67408\text{E} - 11 \frac{(9.10938\text{E} - 31) \;\; (9.10938\text{E} - 31)}{1} = 5.538208\text{E} - 71$$

The fundamental force of energy from a fermionic particle, as we have discussed above is:

$$F = \frac{\hbar \, c}{r^2}$$

The momentum radius of an electron at rest is as we have also discussed:

$$r_e = \frac{\frac{1}{2}\hbar \, c}{E} = 1.9307965412216\text{E} - 13 \text{ m}$$

We find the difference in force $F = \frac{\hbar \, c}{r^2}$ at 1 meter, for the far side of the momentum radius, and the near side of the momentum radius of the electron:

$$\Delta F = \frac{\hbar \, c}{(r_e - r)^2} - \frac{\hbar \, c}{(r_e + r)^2} = 2.4422502259516\text{E} - 38$$

Where r = 1m.

Then we calculate the force of gravity caused by this differential force of energy from an electron 1 meter away.

$$F_G = \left(\frac{\pi \, \Delta F}{2 \, \alpha}\right)^2 = 2.7636905414375\text{E} - 71$$

So that the gravitational force between two electrons at rest at 1 meter, using this model is:

$$F = \; F_G + F_G = 5.5273811\text{E} - 71$$

This value is slightly lower than the standard Newtonian gravitational force, for some fairly obvious reasons. Our Newtonian gravitational constant is based on empirical measurements of massive bodies. Within these massive bodies, energy is being exchanged between fermionic particles, in the form of

photons, which are also elementary particles, and which also contribute to the gravitational field. One consideration however is that the gravitational field is not caused specifically by mass. The gravitational field a body creates is caused by quantized fundamental energy of all particles within the body, which creates a net displacement force in space. So the number of elementary particles within a body determines the gravitational field that body creates.

The difference in calculated force shows that the Newtonian gravitational force is slightly higher than the theoretical force between two electrons at rest, based on the premise we have suggested. Which agrees very well with the expected outcomes of these calculations including the photonic contribution to the gravitational field.

$$\frac{5.538208\mathrm{E}-71}{5.5273811\mathrm{E}-71} = 1.00201$$

We have demonstrated that the force of gravity is an expected and quantifiable value based on this premise that fundamental energy displaces space in the manner described herein.

The gravitational field is created by the fundamental energy of particles, not by mass. The gravitational field causes the confined momentum within mass to accelerate toward or to produce a force toward the source of that field. The gravitational field also causes photons to be deflected in that field. These causal descriptions agree with what we observe in nature.

## The Magnetic Field of the Electron

In general terms, we know that the magnetic field is a force which is perpendicular to the force of the electric field. It is reasonable to assume then, in this model, that the magnetic field may be an interaction of these spinning displacements due to their transverse motion in space. And in a medium with properties as we have discussed, such a force is predicted, as these displacements of particles spin and interact.

Since the magnetic field would be the transverse interaction of these displacements, an electron moving in relation to the measuring object, creates a larger magnetic field. This effect of motion on the magnetic field is therefore relative. It does not matter if the electron or the measuring object are moving, the resultant transverse interaction of displacements is still increased. This effect also gives the appearance of relativity to the electromagnetic interaction. The increase in the transverse interaction of displacements for moving objects is principally due to the increase in energy of a moving object, causing a higher spin rate of the elementary fermions in the object. Only a tiny (almost immeasurable) amount of this increase is due to the linear translation of the moving displacements. Note: Free accelerated elementary fermions naturally tend to align their magnetic poles with the direction of motion.

The creation of electromagnetic fields, by these spinning longitudinal displacements which create particles, provides a single causal mechanism which results in the observed phenomena of electromagnetism. A clear, simple, fundamental, and concise definition of these phenomena is afforded by this model of space and its reaction to the energy of particles.

One thing we need to recognize is that our accepted general theory of electromagnetism is based on our observations. We measure the magnetic field created by a known current flowing through a coil of wire and base our theory for magnetism on such measurements. But the electron itself is far more fundamental than the collection of electrons, protons, and neutrons which comprise the wire. The external net magnetic field we sense when current flows through a wire is not the whole story. What we are able to observe of this magnetic field are results which are caused by a quite complex set of circumstances. But the actual magnetic field of a single electron is far simpler and more efficient than what we can measure in experiments like current flowing in a wire. We prove this point when we measure the magnetic moment of the electron itself. In that experiment we find that the electron is generally 2.00231930436182 more efficient in creating a local magnetic field than current flowing in a wire. This is the famous electron g factor (value from NIST CODATA). So the magnetic moment anomaly (and the g factor) of the electron is not actually an anomaly of the electron at all, but rather an artifact of our measurement capabilities which are in general of gross macro-scale magnetic effects. Our measurements of these gross macro-scale effects disclose only a portion of the full story regarding elementary particle magnetics. The magnetic moment of the electron is a clear indication of this set of circumstances.

The interaction force magnitude between two magnetic dipoles, like two electrons at rest, is:

$$F = \frac{a_\tau \, 3 \, \mu_0 \, {\mu_e}^2}{2\pi \, \boldsymbol{r^4}}$$

Where $a_\tau$ is a unit vector, $\mu_0$ is the magnetic constant of free space, $\mu_e$ is the magnetic moment of the electron, *F* is force, and *r* is distance.

The magnetic B field intensity of an electron at rest is:

$$B = \left(a_\tau \, 2 \, cos\theta + a_\theta \, sin\theta\right) \frac{\mu_0 \, \mu_e}{4\pi \, \boldsymbol{r^3}}$$

$a_\tau$ and $a_\theta$ are unit coordinate vectors, tangential and radial, and θ is the angle between the dipole axis and a line in the direction of the measured point.

The force of interaction of magnetic fields of two identical charged elementary fermions can then be expressed as:

$$F = \frac{f \, K_{mag}}{r^4} = \frac{f \, \frac{(\hbar \, \alpha)^2}{4}}{r^4} = \frac{f \, \hbar^2 \, \alpha^2}{4 \, r^4}$$

Where $f$ is internal particle frequency we previously discussed $f = \frac{2\sqrt{2}\,E}{h}$ (3.494775804128380E+20Hz), $K_{mag}$ is a constant $\frac{(\hbar \, \alpha)^2}{4}$ equal to 1.480549647313120E-73, and $r$ is distance between the particles.

$$K_{mag} = \frac{(\hbar \, \alpha)^2}{4} = 1.480549647313120\text{E} - 73$$

$$f = \frac{2\sqrt{2}\,E}{h}$$

So that the (scalar) force magnitude of the magnetic field between two elementary fermions can be summarized as:

$$F = \frac{\sqrt{f_1 f_2}\,\alpha^2\,\hbar^2}{4\,r^4}$$

We are therefore able to show the magnitude of the force of magnetism and illustrate a simple causal mechanism for the fields and forces we measure in experiment. Each of the forces of nature are systematically and clearly described by this interpretation of the reaction of space to the fundamental energy of particles. Which offers compelling credibility to Bell's suggestions and greatly simplifies the study of quantization and relativity.

## The Appearance of Relativity

The description of the reaction of space to fundamental energy proposed herein, also provides a clear description of the underlying cause for relativistic transformations, and description of the behavior of electromagnetic fields when studying moving bodies.

I. Length Contraction

If space is this sort of specialized tension medium, and if light and elementary fermions are made of the same general reaction of space to energy, then elementary fermions naturally undergo changes when accelerated to near light speed. We have addressed some related issues above when discussing the rest mass of the electron. The topology of circulation of these spinning longitudinal displacements would be different for a moving particle than for a particle at rest. This suggests that the otherwise spherical charge field of an elementary fermion would flatten and be shorter in the direction of motion. And since the charge fields provide the forces which hold atoms and molecules together, an object in motion would become shorter in the direction of travel.

II. Time Dilation

The principal means for atoms to exchange energy is by using photons. If we measure time as the rate at which atoms can exchange energy via photons then time will also be slowed by our motion through space. In fact any exchange of energy which has a fixed velocity will be slowed by motion through space.

III. Relative effects of Electromagnetic Fields

We have shown how electric charge is caused by longitudinal displacements of space toward the center of a charge particle, and how these displacements spin, creating magnetic fields due to the transverse motion. Using this premise it is quite easy to understand why it is that moving a charge creates more spin and transverse motion of these displacements and therefore more magnetic field. This premise also explains specifically how the fields of particles interact to create the forces of electric charge and magnetic fields. So we can clearly see why moving a magnet past a wire creates the same effect in the wire as moving a wire past a magnet. The behavior and interaction of the fields we have described cause electromagnetism to be "relative".

Planck action implies a radius of action. We have suggested that this radius is clearly defined by the evidence available. When we discussed the rest mass of the electron we addressed the width of displacement at the momentum radius of the electron at rest, and in motion. The properties of space which cause momentum also have an effect on the topology of spin of a particle. This effect that momentum has on spin is one reason that electromagnetic fields transform for a particle in motion. Objects made of particles, bound together by these electromagnetic fields, also therefore transform when in motion. The Lorentz transformations based on the Pythagorean Theorem, the transformations we observe in nature, would occur if the local velocity in space of the transverse motion of spin at the momentum radius of particles were $\sqrt{2}\,c$.

Using this model for space and its reaction to the fundamental energy of particles provides a clear path to understanding how our universe is a Euclidian 3 dimensional universe, and how particles are formed. This model provides an understanding of quantization, and relativity, in a single theory.