Space Density Relativity & Higgs Field Occupancy

Relative Spacetime Density, Particle Mass, and the Quantum Effects of Gravity

Colter Dallman

NOTE TO THE READER

There has been a long running standstill in progress toward reconciling general relativity and quantum mechanics. This standstill will likely continue unless there is significant shifting of these major paradigms in the field of theoretical physicists. Bearing this in mind, it should be expected that endeavoring to discover the means of quantum gravity will require thinking beyond the bounds of the conventionally held constraints. Thus, the fact that the components of the theories provided herein push the bounds of the current paradigm is a crucial part of the progress made by them.

Due to this, it is suggested that the reader refrain from denouncing the combination of these two theories as describing quantum gravitation prior to completing the entire text. This text is meant to provide the fundamental concepts required to understand quantum gravity, rather than being a technical paper describing it mathematically. The principles of space density relativity and Higgs field occupancy have been laid out here in their simplest form, building upon basic concepts. It was in the process of deriving an understanding of how the geometry of spacetime influences quantum particles to cause gravitation that the origin of particle mass presented herein was discovered.

The reader will find that equations are almost entirely absent in this volume. This is due to focusing on how the theories of quantum mechanics and general relativity must be adjusted to conceptualize quantum gravity. This clarified theoretical understanding should provide the foundation required for the derivation of the desired equations.

Preface

As suggested by the title, two new concepts for theoretical physics are described in this text: space density relativity and Higgs field occupancy. Within the body of the text, the two theories are intermixed, just as they are in nature to cause gravitation in the first place. The reason the concepts are presented in this somewhat confusing order has to do with the order in which they were first theorized by the author. Hopefully presenting the concepts in the same order as they were first understood will be conducive to the reader's understanding, as well. It is the end result of combining these two theories—one describing the geometry of spacetime and the other describing the quantum nature of elementary particles—that a self-consistent depiction of quantum gravitation is formed.

In space density relativity, the fundamental characteristic of spacetime which allows it to vary from Euclidian—as described by the Einstein field equations—is uncovered. It will be unveiled that what Einstein referred to as the curvature of spacetime is actually the result of spacetime's variance in relative density due to the presence of energy within it. When this smooth variance in relative spacetime density is examined on the sub-atomic scale, one can begin to see the means by which gravity occurs, picking up where Einstein's general relativity left off and carrying it to its most minute operations.

In the theory of Higgs field occupancy, the quantum nature of fermions is explained to show that they have quantum wavefunctions which occupy a spherical area of spacetime. This property of fermions is shown to be what gives them their attributes of rest mass and inertia, as well as what prevents them from traveling at the speed of light.

Finally, when the spacetime occupying nature of fermions described by Higgs field occupancy is introduced into the structure of spacetime described by space density relativity, the first plausible explanation for how individual fermions are gravitationally accelerated by the geometry of spacetime is achieved. Thus, these two theories combine to explain the quantum origin of gravitation, without requiring the supposition of multiple extra dimensions or unfound theoretical particles. Perhaps most importantly, these theories can be shown to provide new experimental predictions.

In addition, space density relativity can be applied to explain many of the currently misunderstood pieces of observational evidence, and to larger theories of cosmology altogether. Those implications, however, will be reserved for a separate document titled *Applications of Space Density Relativity*.

Contents

I. EINSTEIN'S ROTATING DISK

The text of these theories will be begun with a critical analysis of one of the thought experiments that Albert Einstein described in his General Theory of Relativity. This is a suiting place to start, because space density theory builds on the dynamic proposition that was put forward in general relativity: the idea that the geometry of spacetime varies from Euclidian.

In his explanation of general relativity, Einstein introduced the concept of spacetime and described that both distance and time are relative. Space density theory provides a description of just how it is that spacetime varies relatively, and that this relativity of spacetime is most appropriately understood as a variance in relative density. This conception can be applied to not only to the largest scales, but also to the smallest, all the way down to individually isolated elementary particles. To begin with this from where Einstein did, his rotating disk thought experiment is a good place to start.

In the section of the General Theory of Relativity titled "Behaviour of Clocks and Measuring-Rods on a Rotating Body of Reference", Einstein implemented a rotating body of reference to show how the effects of special relativity can be applied generally to gravitational fields. In the outset of this section, Einstein interestingly calls upon the reader saying, "this matter lays no small claims on the patience and on the power of abstraction by the reader." For the same reasons, I will lay down this same caution again to the reader of this theory.

In the details of the thought experiment, an observer is sitting at the center of a disk which is rotating about its center with constant speed relative to its surroundings. Einstein placed a clock at the center of the rotating disk and one at the edge of the disk. He also placed two measuring rods on the disk, one next to each clock. The rods lie parallel to one another, with the one on the disk's edge being tangential to it. Both of the measuring rods are of identical construction, as are the clocks.

The rotation of the disk gives the objects on its edge relative velocity with reference to the non-rotating surroundings. The observer will notice that the clock at the edge of the disk ticks more slowly than the one at the center, due to the effects of special relativity. The observer will also notice that the measuring rod at the edge of the rotating disk experiences length contraction and becomes slightly shorter. This was where Einstein made the prediction that clocks and measuring rods in gravitational fields will also vary relatively.

If one were to place additional measuring rods and clocks on the disk in the same fashion between Einstein's two clocks and measuring rods, they would see that there was a gradual increase in these effects from the center of the disk out to the edge. The clocks would tick more slowly and the measuring rods would experience more length contraction the nearer they were to the edge. Einstein compared this effect to that of the location within a gravitational field. This increasing degree of length contraction and time dilation would represent the gradient of a gravitational field, which will be talked about extensively later in this document.

Because Einstein had previously recognized that inertial acceleration and gravitational acceleration are undifferentiable to an observer, he was able to declare that the constant force felt at the edge of the spinning disk is equivalent to that of a gravitational field of equal intensity. Therefore, he could relate these effects on the rotating disk must also be present in gravitational fields. So, by noting that the clock on the edge ticks more slowly and the tangential rod there appears shorter, we can conclude that time passes relatively more slowly and lengths are relatively shorter in areas of increased gravity, and that these effects must be present in all gravitational fields, the degree of which is dependent upon the position in the field.

It is now well understood that time passes more slowly in areas of increased gravitation because this effect has been proven with clocks, but this has been impossible to do so for the measuring rods because they cannot be compared relatively afterward for temporary changes that occurred to them while they were temporarily in an increased gravitational field as can be done with clocks. This may be one reason why the length contraction effect also predicted by general relativity seems to have been forgotten, though extending both of these qualities equally would mean that if time dilation occurs physically in gravitational fields, then length contraction must physically occur as well. This largely overlooked effect of gravitational fields on spacetime that was predicted by general relativity is central to the concept of spacetime density.

It is clear that this length contraction problem for general relativity causes some perplexing results, considering that it means that all objects shrink relatively when entering stronger gravitation fields. But, as we have found that clocks truly do physically tick slower in increased gravitational fields, we must also assume that measuring rods do physically undergo length contraction in increased gravitational fields. And, just as the fact that clocks tick slower in increased gravitational fields indicates that time passes relatively slower in increased gravity, the shrinking of measuring rods indicates that space becomes relatively more compact in increased gravitational fields. It is because this critical component of general relativity has been ignored that spacetime has continued to remain misunderstood.

II. QUANTUM RELATIVITY

In this section, the noteworthy results that appear on the atomic and subatomic levels with a more detailed examination of the length contraction in gravitational fields are analyzed. With this, the first glimpse of the mechanisms that cause gravity from the quantum level is revealed. To get there, more detail must be filled in to this concept of length contraction and the shrinking of atoms within the measuring rods on Einstein's rotating disk.

Just as length contraction increases for the measuring rods on the rotating disk with increasing distance from the center, the length contraction *within* each measuring rod must increase with distance from the center of the disk. When considering this on the atomic scale, the location of each atom within the measuring rod must be considered according to their distance from the center of the disk. Because this length contraction is being generalized to gravitational fields, we must assume that the length contraction must increase for each atom the lower it goes in a gravitational field.

Now, because this effect of length contraction must be smooth, there still needs to be more stringency in its application. If the length contraction is considered separately from one atom to the next, jumps in degree of contraction occur with the distance across the diameter of each atom outward along the radius. So, to attain an authentically smooth effect, as must be expected for this length contraction to remain smooth in gravitational fields, just as it would on the rotating disk, the degree of length contraction must also be expected to increase *within* each atom. Thus, the side of an atom that is lower in a gravitational field must undergo slightly more length contraction than its upper portion.

One may wonder whether this length contraction across atoms by gravitational fields is what causes gravity, especially considering that the gravitational force from atoms is mostly due to the electromagnetic force between the nucleus of the atom—where most of its mass is held—and the electron cloud. However, it is understood that gravity acts individually on the masses of the sub-atomic particles within atoms rather than whole atoms. So, the smooth effect of length contraction throughout the gravitational field must be zoomed in on once again to look at the sub-atomic molecules within atoms. Because it is understood that most of the mass within atoms is held in their nuclei by the protons and neutrons there, this analysis of absolutely smooth length contraction across the gravitational field will be taken to those baryons next.

Because the baryons within the nuclei of atoms are known to occupy spacetime, just as the atoms within measuring rods do, the same effects of length contraction that occur across atoms must also occur across each baryon. To get a picture of what this might look like, one must be able to get a view of what a baryon looks like. Usually, protons and nucleons have been represented as being spherical, as they will be represented here, but the reason for that should be given a little discussion here before moving on.

It is well known that each proton and neutron is composed of three quarks which are held together by three gluons of the strong nuclear force. The conglomerated bonding of the quarks by three gluons is what forms the larger composite fermions called baryons. The curious part here is that any connecting three points will make a triangle, not a sphere. The reason it is accurate to represent baryons as spheres rather than triangles has to do with quantum mechanics. Basically, because of quantum probability, all of the possible orientations of the three quarks in space can be said to blur into one spherical wavefunction. In other words, the wavefunction of the three quarks is a sphere in which all possible orientations of the triangle exist.

To assume a baryon to be a sphere, it must be envisioned that the individual quarks and gluons do not actually exist in any particular location (unless they are directly observed and located to collapse the wavefunction) while they are bonded together in the composite baryon, but rather they disappear into a larger, united wavefunction within which the quarks can be in an infinite number of positions. Indeed, this same notion should be able to be extended to all composite particles. For instance, when considering mesons, the separation between the two fermions comprising them could be considered to be the diameter of the composite meson's wavefunction, in which the two individual fermions could be in an infinite number of positions. As will be covered in the next section, this same effect must also be considered for elementary fermions due to quantum properties.

Now that it has been covered why the baryons that exist in the nucleons of atoms—and all other fermions (which will be defined for the purpose of this text as any individual particle that is not a force carrier boson, so any individual elementary fermion or individual composite particle composed with elementary fermions) that compose matter—can be considered as spherical three-dimensional objects, the logical basis for why they can be represented as circles in two-dimensional figures, as the reader will find they have been drawn for visual representation in this text, has been given. Figure 2.1 below has been drawn to show what the application of a completely smooth relative length contraction across any fermion (as defined above, and thus including mesons and excluding whole atoms and atomic nuclei) would look like.

In Figure 2.1, the perfect circle on the left represents a fermion in the absence of a gravitational field, and the smoothly contracted circle on the right represents the length contraction effect that a gravitational field will have on a fermion. The length contraction must apply to the particle smoothly throughout the continual gradient caused by a gravitational field, with relatively more length contraction occurring at the bottom of the particle than at the top. As depicted in Figure 2.1 below, the fermion in a gravitational field will have its center point moved downward by the length contraction caused by the gravitational gradient compared to if it were in the absence of a gravitational field.

Gravitational Field's Effect on a Fermion

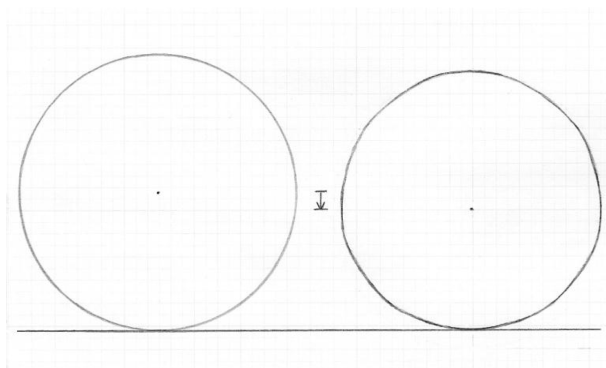

Figure 2.1: The relative length contraction on the fermion in a gravitational field (right) is shown in comparison to the natural circle that it would be in the absence of a gravitational field (left). This difference exists at all times the fermion is in the gravitational field. The effect of this relative length contraction is shown to shift the fermion downward.

As Figure 2.1 depicts the effect of a gravitational field on an individual particle, it can be considered to reveal the quantum effects of gravity. This application of the blindly overlooked length contraction effect of general relativity to the quantum scale could be called quantum relativity, which has notably been chosen for the title of this section. This view of the length contraction effect on fermions by a gravitational gradient can be extended to provide a fundamental quantum explanation for why all matter undergoes the same gravitational acceleration within any given gravitational field.

To advance the effect of quantum relativity provided by Figure 2.1 to the view of what happens to an individual fermion in gravitational freefall, the effect of looking at the fermion as it moves down in a gravitational field over time needs to be pictured. Figure 2.2 below shows how the shifting of a fermion downward by a gravitational gradient depicted in Figure 2.1 above will result in the continual acceleration of the fermion downward in a gravitational field over time, the effect known as gravitational freefall.

Fermion in Freefall

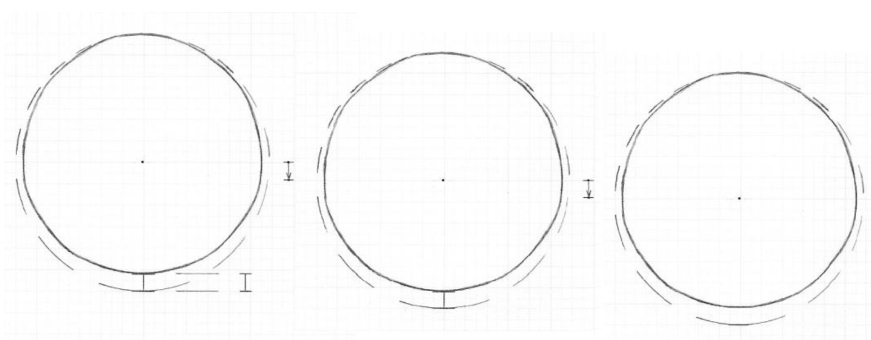

Figure 2.2: In this diagram, the length contraction that shifts a fermion downward in a gravitational gradient is depicted over time from left to right, with the three length contracted circles representing the same fermion in three successive moments in time. The dashed circle represents what the radius of the particle would be if it were not experiencing length contraction from a gravitational field, in effect showing the amount of relative change caused in the length contraction of the lower radius. The fermion will continually undergo this length contraction, shifting it downward with each successive moment that it exists in the gravitational field. Thus, the length contraction itself is what causes the steady gravitational acceleration. So long as the particle is unimpeded from moving downward in this fashion, it will be accelerated downward though feeling at rest in its own reference frame—as expected for gravitational freefall.

As written in the figure's notes, Figure 2.2 shows how gravitational freefall results from the effect of relative length contraction predicted by general relativity. As the effect crudely depicted by Figure 2.2 occurs and the particle falls downward, the entire particle will continually experiences more and more length contraction as it moves downward in the gravitational gradient. Thus, the entire particle will become relatively smaller as it experiences greater length contraction as it moves downward in the gradient. The meaning of this result is that the way in which the distortion in spacetime described in general relativity causes gravitational acceleration has now been uncovered and applied to individual particles.

If freefall is not allowed, the combined continual force of the displacements of all the fermions in any object will amounts in the total weight of the object. By this, the origin of weight from the quantum level has been uncovered. Of course, there is more to be described for this quantum theory of gravity to be complete. In the next section, the origin of particle mass that has been hinted at here is described in more complete detail.

Drawing from this, for a particle to have weight, it must have a non-zero diameter and thus be able to span a gravitational gradient. This is what makes it possible for there to be a difference in length contraction between the top and the bottom of the fermion in the first place. When analyzing this effect, it will become clear that the mass of each fermion must be derived directly from its diameter, which is a foundational principle of Higgs field occupancy.

III. HIGGS FIELD OCCUPANCY

To move on with this idea of quantum relativity, the way in which fermions are endowed with rest mass must be explained in further detail. As briefly proposed in the previous section, it is the property of spanning some amount of spacetime that allows fermions to be gravitationally accelerated by a gravitational gradient. This “spanning some amount of spacetime” will now be defined more specifically, as that all particles with rest mass occupy some amount of the Higgs field that permeates all spacetime.

It is a foundational principle of Higgs field occupancy that the rest mass of any particle is always directly proportional to the amount of Higgs field its resting wavefunction takes up. This concept is one that most especially pushes the bounds of conventional restraints, as the currently held interpretation of quantum mechanics defines elementary fermions to be point particles of zero size. As will be described, the fact that elementary fermions appear as point particles when observed does not mean that they exist as point particles when not directly observed. Much to the contrary, due to quantum probabilities, even elementary fermions must have wavefunctions of non-zero size when not observed.

Therefore, when referring to a particle’s diameter, it is the diameter of the particle’s undisturbed resting wavefunction. This was what was referred to in the discussion addressing how a triangle of quarks connected by gluons can have a spherical wavefunction. Even more specifically, the use of the term wavefunction here refers to the area in which there is probability that the fermion—or, in the case of a composite fermion, one of its constituent fermions—may be found in the specific case that the fermion is known to be at rest in one frame of reference (as to be removed from the use of the term wavefunction to describe things such as that of an electron in an electron orbital, where the velocity is unknown and the wavefunction includes all possible velocities of the fermion).

This all has to do with the Heisenberg uncertainty principle. Because the location and velocity of any particle cannot be simultaneously measured to any high degree of certainty, the precise location of a particle cannot be known while the precise velocity of the particle is known. A proper understanding of the uncertainty principle provides that is not only a “measurement problem” as it is presented in many simplified versions. Thus, this is not only an observational effect, but a real quantum property of particles. This means that if the velocity of a particle is known, that particle cannot have a specific location, but rather the particle can be found in an infinite number of locations. Here though, it must be understood that this infinite number of locations in which the particle can be found is confined into a finite area. This set amount of area for the particle will later be defined as the particle’s Higgs occupancy diameter.

To imagine this, one must imagine having a particle that is at rest in the observer’s frame of reference. This, of course, can only be figured for fermions, because bosons always travel at the speed of light cannot be considered at rest in any observer’s frame of reference. In the case that that the velocity of a fermion is known, its location cannot be known to high precision. But knowing the particle’s precise velocity (which is at rest to the observer in this example) only prevents us from knowing the exact location of the particle; it does not mean that the particle can be located anywhere in the universe. We should be able to determine an area in which the particle must exist while it is co-moving and we are not observing it. In this way, although we cannot know the exact location of a particle while its exact velocity is known, a finite area in which the particle exists should be ascertainable.

With regard to the different fermions, we might ask to compare if this finite amount of area differs between them. It makes sense that the wavefunction of a particle with more rest mass would take up a larger area than a particle with less mass. And, it does follow logically that the larger the energy contained in the particle, the greater the diameter of the area where it is possible that the particle can be found. This can be understood in saying that the greater the energy contained in a particle, the greater the volume of space required to contain it. Add to this the fact that the energy content in a particle is synonymous to the particle's rest mass, and each fermion should have a diameter which is directly proportional to its energy content and rest mass. This would then make sense of the otherwise not understood component of what gives the elementary fermions their different masses.

Regarding this, it should be officially proposed that the characteristic determining the rest mass of any particle—the amount of Higgs field the wavefunction of the particle takes up—shall be known as *Higgs field occupancy*. Here, the name Higgs is being kept as to continue the proposition that there is a Higgs field that gives particles their mass, though no Higgs boson is required in this theory's account for the mass of fermions. (Nonetheless, the Higgs boson is still required to give mass to the W and Z bosons.)

In this description of the interaction, the origin of rest mass for fermions is much to the contrary of requiring any boson. Rather, the Higgs field itself—most easily considered as the general non-emptiness of spacetime—is what allows the occupancy of spacetime by fermion wavefunctions. The fact that elementary force carrying bosons can never have rest mass goes beyond the fact that they can never be at rest—as they always must travel at the speed of light while they exist—but that they truly have zero size and do not have the attribute of Higgs field occupancy. (This is why the W and Z bosons require the Higgs boson to give them rest mass in their “symmetry breaking” effect through the Higgs mechanism.)

Higgs field occupancy by fermions is, in effect, what allows energy to be stored in particles as rest mass in the first place, as opposed to existing as radiation like photons which do not have size or rest mass. Therefore, three-dimensional Higgs field occupancy is the very means by which energy exists as matter rather than radiation, though the two are equivalents of the same thing—as shown by Einstein’s famous $e = mc^2$ equation. By this explanation, the mass of any fermion should be derived directly from the amount of Higgs field it occupies—or, in other words, the fermion’s Higgs field occupancy diameter. (To avoid redundancy when referring to a particle’s Higgs field occupancy diameter, it can simply be called the particle’s *Higgs diameter*.)

The characteristic of Higgs field occupancy for fermions is absolutely crucial in both understanding particle mass and gravitation. The fact that fermions must occupy a non-zero amount of space was already discussed regarding Figure 2.1 and 2.2. Now it makes sense that was referring to Higgs field occupancy. Thus, it is Higgs field occupancy which allows for fermions to be accelerated by gravity. The Higgs diameter of a particle will also be found to be what gives the basis for inertia, as will be discussed later in this text.

The concept of Higgs field occupancy is beautifully exemplified by the fact that composite hadrons gain a huge amount of mass when quarks are united into a larger wavefunction by gluons. This effect of gained rest mass is otherwise odd considering that the mass of the composite particle is far more than the sum of the rest masses of the quarks and gluons combined. It makes sense that hadrons gain rest mass when joined into composite particles because of the increased volume of Higgs field occupied. Because the composite particle has a larger Higgs diameter, there will be more length contraction across it in any given gravitational field than across a particle with a smaller Higgs diameter in the same gravitational field, and thus it will weigh more simply due to its spanning a larger amount of spacetime.

Building from the fact that the rest mass of any particle results directly from its Higgs diameter, it must be concluded that the rest mass of any object must be the sum of all the Higgs diameters of the particles that compose it. Furthermore, it must be the Higgs diameter of a particle multiplied by the local gravitational gradient that results in a particle's weight. And, as explained earlier, the local gravitational field is determined by the change in the degree of length contraction across that field. (This attribute of length contraction across a gravitational field will be further clarified in the following sections, where the actual concept of spacetime density relativity is clarified.)

With reference to Einstein's rotating disk thought experiment, if the disk were rotating at a faster rate, there would be a greater difference in length contraction between the center of the disk and the edge. This increased length contraction across the disk could be generalized to represent a stronger gravitational field. Thus, it is the increased length contraction across a particle's Higgs diameter in a stronger gravitational field that causes a particle to weigh more in a stronger gravitational field, though it continues to have the same rest mass. Extending this to all bodies composed of matter results in a quantum explanation for why one object will have differing weights in gravitational fields of different strength.

As proposed, this gives an entirely new and unprecedented clarity and understanding to the origin of mass and the cause of gravitation. It should now be becoming clear to the reader that to extremely simple explanation of the combination of principles from general relativity and the new proposition of Higgs field occupancy gives unprecedentedly clear foundational understand for quantum gravity. This has all been done without even beginning to discuss spacetime density relativity specifically. In the next section, a concept is proposed that allows for the overlooked proposition Einstein made regarding length contraction and spacetime curvature to be envisioned more truly for what it is, variance in relative spacetime density.

IV. THE INVARIANT BACKGROUND

With the concept presented in this section, the fundamental difference between inertial and gravitational acceleration can be shown. With this concept, it can be shown how a rotating body of reference—such as that used in Einstein's rotating disk thought experiment—and a gravitational field are not the same. Though the equivalence principle that was used to generalize the effects on the rotating disk to gravitational fields still holds true, there is a physical difference in the origin of acceleration on the rotating disk and in a gravitational field.

While there is no real length contraction of objects on a rotating disk, but rather merely an observational effect, there truly is length contraction in a gravitational field. This is the root of the spacetime curvature that has been proven by observations such as gravitational lensing. To show why the previously described and diagramed quantum effects of gravitation do not really occur on a rotating disk, but that they do occur in gravitational fields, a background to compare relative length contraction upon must be invented.

To get to the reason for why a background is needed to see the relative length contraction of gravitational gradients, a new thought experiment could be used. Imagine sending two identical measuring rods into two different fields of spacetime to try to measure the degree of length contraction there. There is a problem with this, because if one sends a measuring rod into a region to undergo length contraction there, and then sends a second measuring rod to check the degree of length contraction the first measuring rod underwent, the second measuring rod would undergo the same amount of relative length contraction in route there, so we could never find out about length contraction in such a way.

Furthermore, unlike clocks which can be compared afterward to check the amount of elapsed time they have recorded, the measuring rods will not hold any evidence of having undergone relative change for a period of time upon coming back from the differing field. This is what makes the general relativistic length contraction effect in spacetime much more difficult to have solid evidence for than the already proven general relativistic time dilation effect in spacetime. Nonetheless, there should be a way to envision the length contraction effect of general relativity which would allow a better understanding of the structure of spacetime needed to envision space density relativity. So, let us humor this idea and clearly lay out the experiment and follow where it leads.

To start, the experiment begins with two measuring rods which are identically composed meter sticks. We will be keeping one here on Earth and sending the other to Jupiter. By faith in the theory of space density, we will say that the meter stick sent to Jupiter will shrink relative to the one kept at Earth upon entering Jupiter's stronger gravitational field. This result would then face us with some peculiar questions: Is the meter stick at Jupiter still a standard meter, or is it now less than one? Do we call this shortened meter a Jupiter meter as compared to an Earth meter? Moreover, how could we ever tell the difference?

A sharp theorist might interject here to say that the most precise standard to measure a meter would be to use the fact that light travels one meter in 3.3 nanoseconds. One could say that an experiment based on this standard ought to solve the problem once and for all, in that the speed of light is invariant. The theorist might be onto something here, but this subject will have to be returned to later due to there being much involved with the speed of light that we must cover first in order to analyze that detail. Now, to continue where we need to go for the time being, I will bring into view this idea of an invariant background.

From the dialog of general relativity, we know that spacetime varies from Euclidian. One way Einstein described this in the theory was with reference to a marble table with a matrix of unit-length rods placed into squares on it being heated in one portion, as to make the rods there expand, causing the corners of the squares made with the rods to vary from right angles where the heated and expanded rods came to meet the rods that had not be heated. Still, if one maintained the view of the rods all being equal length, or if they tried to measure the existing rods with ones that would equally expand with the heat in the heated portion, they would continue to believe that the whole matrix was still made of squares.

However, if we used measuring rods of material that does not expand with heat—as to be invariant to the relative changes—the matrix on the table could be checked again and in a way that would reveal it to vary from Euclidean. In this way, the heat-invariant rods could be used to measure relative change no matter the degree of heat on the slab, and would show how the relatively changing measuring rod matrix on the table varied from Euclidian due to regions on it having different temperatures. Extrapolating this, one could imagine that a matrix made of temperature invariant measuring rods would always be said to remain Euclidean for Einstein's marble slab thought experiment, and could be used to measure the degree of variance from Euclidean from heat at any part of the table.

In the same way, a matrix of meter sticks that were invariant to relative changes in length contraction caused by gravitational fields would need to be imagined for the purpose of my Jupiter meter thought experiment. Such a spacetime invariant matrix would always hold to show how a matrix made of meter sticks susceptible to the length contraction of gravitational fields will vary from Euclidian. Indeed, this framework could be applied to show how all of spacetime varies from Euclidian due to the presence of matter and energy within it.

This framework would have to be separate from spacetime in order to not be influenced to stray from Euclidean like spacetime does with the distribution of matter and energy. This separation could be termed to be in the background behind spacetime. If we imagine an invisible framework everywhere in the background of spacetime with units of length that remain constant no matter the relative local gravitational field, such a framework would be perfect for the task of measuring the relative length contraction of meter sticks throughout spacetime. This theoretical framework, which will remain constantly Euclidean, in contrast to the framework of spacetime which varies relatively from Euclidean at all places depending upon the presence of energy within it, will be called the invariant background.

For clarity, this idea of the invariant background is separate from something that exists within spacetime, making it strictly theoretical. In this way, the invariant background could be envisioned to extend infinitely in all directions—even beyond the bounds of the entire finite universe. This framework will allow us to differentiate between the varying degrees of relative length contraction in any region in the universe. Thus, to really see the relative length contraction that was already depicted in Figure 2.1 and Figure 2.2, the invariant background would have to be invoked. Otherwise, it could never be viewable from within relative spacetime. I find the invariant background easiest imagined as a transparent grid, similar to that of a sheet of graphing paper made three-dimensional, which will show how spacetime varies in density from region to region. Such a tool would be perfect to reference to see the relative difference between the Earth meter and Jupiter meters in this thought experiment still being explained.

We could use the invariant background to simply measure the Jupiter and Earth meter sticks in gravity-invariant units to see if they vary in relative length to one another. According to the theory of space density, if we were able to do this, we would find out that a meter stick near

Jupiter measures shorter on the invariant background than a meter stick near Earth. This would show that meters vary in relative length depending upon gravity, and we could conclude that all lengths are relatively shorter in areas of spacetime where more energy is present. The fact that the meters are still both meters, however, would show our first indication that spacetime is relatively more dense in regions where more energy is present.

Now, with the use of the invariant background, there is a way to differentiate from inertial acceleration and gravitational acceleration, because the relative length contraction gradients of gravitational fields can actually be envisioned with it. Uniting the concepts presented this far, the invariant background would be needed to view the effect of length contraction by a gravitational gradient across a particle's Higgs diameter, which can now be attributed to what was pictured with Figure 2.1 and Figure 2.2, though these concepts had not yet been explained yet at that place in the text.

Now that the conceptual tool of the invariant background has been theorized, it can be used to bring to light the real essence of space density relativity through the explanation of units of space presented in the next section. With the concept of units of space made possible to highlight with reference to the invariant background, the big picture of the variable density of spacetime on which spacetime density relativity is founded really begins to come into view.

V. UNITS OF SPACE

In this section, one of the cornerstone principles of spacetime density variance will finally be explicitly conveyed. Part of the reason for the delay is that the concept of units of space can only be posed with an invariant background for comparison, which was not available prior to the previous section. With a grasping of the concept of units of space, the reader should gain a sense of understanding in what is meant by relative spacetime density.

A unit of space will be defined as a portion spacetime that is a cube when the length of its sides are measured in relative units such as meters, thus giving it a defined standard volume. The actual value of the length of a unit of space is irrelevant, just so long as they all measure the same size relatively. Any time a unit of space were measured or analyzed by observers within spacetime, all of the corners of the units of space would be square. However, when the units of space were viewed on the invariant background, they would be shown not to come together at right angles in the corners, due to the unequal distribution of energy in spacetime causing it to vary from Euclidian geometry.

With this, a more specified description of what Einstein was getting at when he spoke of the curvature of spacetime is coming into view. In effect, when referenced to the invariant background, the straying of the units of space from square shows just how spacetime is curved by the presence of energy within it. Despite the fact that all of the lines of units of space will seem straight to observers within spacetime, the tool of the invariant background allows one to envision that the lines of the cubes actually curve, so much in fact that it is possible for many units of space, despite being cubes in units such as meters, to come together in the form of a large sphere around an object of great mass. With this envisioned, one can see just what Einstein was referring to as the curvature of the structure of spacetime.

To take this farther, because there is variance throughout all of spacetime, small variations must also exist within the borders of units of space, as determined by the presence of energy in the local spacetime. This shows a preliminary description of how the theory of space density portrays a background-independent model. This is one of the reasons that the standard length of a unit of space is arbitrary. It doesn’t matter what size the units of space are defined to have, just so long as they all have a standard length to compare them by relatively.

When thinking of the size and scale of the observable universe, one would first imagine that the best unit to measure units of space with distances such as light-years. However, as time is relative, slowing down and speeding up relatively in regions of spacetime—again, depending on the presence of energy in the region—it becomes confusing to use time in the measure of distance as light-years do. So, for reason of simplicity, a unit of space here will be defined a certain number of meters. (Nonetheless, light-years could be used just as well, as they are also relative units like meters, and would be suitable for larger scales.)

Considering that meters vary relatively in gravitational fields, the fact that each unit of space is measured in meters will cause a unit of space in a region of space with a lot of energy present in it will be relatively smaller on the invariant background than a unit of space in a region of spacetime where there is very little energy present. The extrapolation of this effect is that more units of space can fit into the same area in the invariant background in regions of space where there is more energy present. The only thing that this can mean is that space is relatively denser in regions of spacetime where more energy is present and space is relatively less dense in regions of spacetime where there is less energy present. This is the principle of relative spacetime density.

Space density relativity means that space is relatively denser near to objects of mass and relatively less dense in the absence of objects of mass. To visualize this, one can imagine comparing the relative length of units of space in areas which vary in relative space density on the invariant background. For example, a unit of space would likely be relatively largest in the middle of a void and relatively shortest at the singularity of a black hole. In between, one would find that units of space become relatively smaller the closer in position they are to an object of mass, such as a planet or star.

Now, regarding space density relativity, it is important to keep in mind that space and time vary in unison, just as Einstein described in general relativity. For this description, it is only obvious that where space is relatively denser, time passes relatively slower. Considering this, the fact that time has been found to pass at a slower rate near to objects of mass can be considered an effect of spacetime density relativity.

In the same way that an observer in a region of denser spacetime will not notice the rate of time to pass relatively slower, they will not notice that distances become relatively shorter. In other words, because the variation in the rate of time and the variation in distance always vary together relatively, a second will always be experienced as a second and a meter stick will always represent a meter to the local observer wherever they go. It is a function of the rate of time and length contraction varying together that allows space-time intervals to be invariant across all local regions of spacetime. Furthermore, these two factors of spacetime must vary in unison for the speed of light to remain constant for all observers.

The fact that the time component and the space component of spacetime always balance one another to this effect is the reason why space density variation has been able to remain unaccounted for without causing too many inconsistencies in physics. Nevertheless, there have been problems observed due to the neglect of this fundamental component of spacetime—most of which have been lumped under the terms dark matter and dark energy. Those issues, however, will be left for discussion in a separate document, as noted in the preface.

In the next section, the gradients of length contraction discussed earlier to amount to gravitational gradients are described with the concept of space density relativity to be space density gradients. Spacetime density gradients have already been proven to exist as gradients in the relative rate of time by measuring the passing of time in different locations in the gradient with clocks and then comparing the time elapsed, but they have not been properly represented to also be gradients in relative length.

Nonetheless, the expectation of the gravitational acceleration that results from these gradients has been engrained in you all from birth as a given fact of nature. Thus, the proof of the space density gradients has always been a part of the experience of life. In other words, everyone has always seen the effects of these unseen gradients, though we are only now beginning to get a grasp of what they really are.

VI. SPACE DENSITY GRADIENTS

Like the smooth gradient in spacetime that has been shown to exist around the Earth in which time dilation decreases with increasing distance from the Earth, a smooth gradient of decreasing length contraction must also exist with increasing distance from gravitational bodies such as the Earth. These gradients in spacetime that gravitational bodies cause around themselves are what Einstein referred to as the warping of spacetime that he theorized to be the cause of gravitation. When considering the space component of such spacetime gradients individually, they can be referred to simply as space density gradients.

The understanding that gravitational bodies cause space density gradients around themselves proves to be a far better description for the warping of spacetime than the old representation in which a stretched out tarp is used to represent spacetime, with the warping of spacetime being represented by how the tarp warps downward towards an object of mass when it is placed on it. While this older tarp representation requires the assumption of a gravity already to pull the object of mass downward on the tarp, the idea of a space density gradient being caused around a body of mass does not require the presupposition of gravity already.

Moreover, the description of gravitational bodies causing spacetime density gradients around themselves actually explains what exactly the warping of spacetime Einstein referred to truly is. To more specifically describe what Einstein was getting at when talking about the warping of the structure of spacetime that is spacetime density gradients, a smaller scale representation of the structure of spacetime than units of space would be useful. Something conducive for this is the conceptualization of the *zero-point field*.

The zero-point field has been theorized to permeate what would otherwise be considered empty space. It is thought of as the ground-state of spacetime, or the lowest energy state of spacetime. In other words, the zero-point field is our representation of what spacetime itself is composed of, and thus a recognition that it is not pure emptiness. As the Higgs field was simply described earlier in this text as the non-emptiness of spacetime, the zero-point field could also be considered to be a representation of the Higgs field.

It should be pointed out that the use of the zero-point field here is not the same as the traditional view, as it will not be used with reference to quantum fluctuations such as that of virtual particles. Instead, the zero-point field will be used simply to represent the substance of otherwise empty spacetime. Obviously, if one has the idea in mind that space is a pure void, it would be hard for them to picture it coming in different densities. However, as physicists have now realized that spacetime itself is something, it should not come as such a surprise that it varies in relative density.

So, just as the use of the term fermion is different in this text than current conventional physics, the term zero-point field in this text has a different use than that used by quantum perturbation theory. With regard to the theory of space density, the zero-point field will be used to illustrate the topography of space density gradients. This use of the zero-point field will have to do mainly with the utility of individual *zero-points*, which indicate localities in the manifold of spacetime, which is smooth even on the quantum scale. This use of zero-points in the zero-point field is helpful in conceptualizing the non-rigid, continuous fabric of spacetime.

The zero-points can be conceived as infinitely small, zero-dimensional points of zero size in space which are separated from one another spatially as space-time intervals. Zero-points will be assumed space-like points in all instances, except for when otherwise specified as time-like—as they will be used in discussing time density in the section on time-space relativity. (As a sort of pre-view, when zero-points are analyzed as time-like, the separation between them can be seen to be what derives the relativity of the rate of time: the greater the separation between zero-points, the faster the rate of time; and the closer together the zero-points, the more time dilation. The effect of length contraction with the space-like view of zero-points that will be represented here first for space density gradients is more self-explanatory.)

A central quality of the zero-point field is that the variable relative separation between zero-points, which represent standard space-time intervals, is what keeps all spacetime at the same relative density for local observers in any region of spacetime. By the same means, the relative variance in the separation of space-time intervals represented by zero-points in the zero-point field can be considered to keep the speed of light constant to observers in any region in spacetime, as was briefly mentioned previously.

As the reader may have already intuited, in regions of denser spacetime, the zero-points of the zero-point field will be relatively closer to one another. Likewise, in less dense spacetime the zero-points will be relatively further apart. Of course, this effect would not be perceivable to the local observer at any region of spacetime, it could only be brought into view with reference to the invariant background.

In a way, the zero-points of the zero-point field can be seen as pseudo-quantification of spacetime. This is said to be pseudo-quantification because the theory of space density is consistent with general relativity, positing that the manifold of space is continuous even down to the quantum scale. Thus, there can be no real quantification of spacetime. Rather, the closest thing that can be done is to mark equal space-time intervals, as was proposed above in units of space for the large scale and is now being proposed here for the zero-points of the zero-point field for the more close-up view of spacetime on the quantum scale.

To combine the two concepts, it could be said that that each unit of space must contain the same amount of zero-point field, and thus the same number of zero-points. This could actually be used as an alternative definition for a unit of space, saying that one unit of space is an area of spacetime in which the defined amount of zero-point field exists. With this in mind, one can see that as a unit of space is relatively larger in less dense space, such as in a void, the zero-point field there must be stretched thinner. On the other hand, in a region of space where there is more energy present, such as in a globular cluster of stars within a galaxy, the zero-point field will be much denser, with the zero-points much closer together.

To further envision the effect of this, one could visualize that if a unit of space were on the edge of a gravitational field, with one side of the unit of space in denser spacetime and the other side of the unit of space in less dense spacetime, there would have to be a gradient in the separation of the zero-points across that unit of space. Moving from the side of the unit of space in less dense space toward the side of the unit of space in higher density space, the zero-points would become closer together. This is how the zero-point field can be used to visualize a space density gradient.

If one were able to view the reference of the invariant background while traveling through space, they would be able to see that as one travels into higher density space—towards a star, for instance—the zero-points of spacetime become closer and closer together. The reverse would occur for such an observer as they travelled into less dense space, with the zero-points of spacetime having becoming more separated. With this, such an observer would actually be seeing the warping of spacetime Einstein first theorized.

The concept of varying density in the zero-point field can be applied to the effect of length contraction that was brought up early on in this text. If space-time intervals become relatively shorter where spacetime is denser, this explains the background cause for the effect of length contraction on fermions by gravitational gradients. A fermion will contract relatively with the zero-point field due to the fact that it will always be the same size in relative space-time intervals. This effect is depicted in Figure 6.1 below, which shows a space density gradient by illustrating the density of the zero-point field upon the invariant background, with three fermion particles in varying locations within it.

Fermions in Zero-point Field across Space Density Gradient

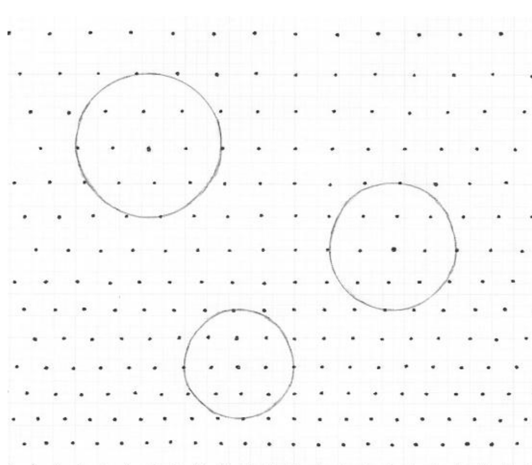

Figure 6.1: The dots on the grid represent zero-points of the zero-point field upon the invariant background, which allows the gradient in their density to be shown. Three fermions of the same diameter (four zero-points) are shown to depict their relative length contraction in the space density gradient. Downward in this diagram correlates to lower in a gravitational field, with the miniscule effect across a field being exaggerated greatly here to bring the concept into view.

As shown in Figure 6.1, the zero-points of the zero-point field are closer together where space is denser, and this causes fermions to be relatively smaller in denser space. It is the presence of the energy contained in the matter of gravitational bodies that causes the spacetime around them to be denser, creating a gradient in space density that decreases with distance from the gravitational body. The fact that the zero-point field is denser and fermions are relatively smaller in the denser spacetime around gravitational bodies is shown with the aide of reference to the invariant background, without which these effects would not be recognizable.

Each fermion within all atoms that exist within space density gradients will undergo this effect, with their lower portions undergoing increased length contraction. This was already depicted in Figure 2.1 and Figure 2.2, though it was not originally explained that the length contraction represented in those figures was caused by space density gradients. Putting all of these factors together results in the conclusion that space density gradients are what cause the length contraction across the Higgs diameters of fermions which results in their gravitational acceleration towards denser spacetime. This means that the space density gradients around gravitational bodies create what we recognize as “downward” in gravitational fields.

It is though this influence of space density gradients on the Higgs diameters of all the fermions within all the atoms that compose matter that the macro-scale actions of gravitation are produced by the micro-scale actions of quantum gravity. In other words, it is the influence of the gradients of relative spacetime density on the individual particles that make up matter that result in all gravitational actions. And all gradients in relative spacetime density are caused by the presence of energy in spacetime.

There are many scales of space density gradients, all of which interact smoothly and are caused by the cumulative effects of the presence of energy within spacetime. Within the large space density gradient caused by galaxies, there are gradients caused by individual stars, and smaller gradients caused by planets, and smaller gradients caused by moons, and so on. All of these space density gradients flow smoothly into one another, and the actions of gravitation play out from whatever the local gradients is among the larger gradients. Usually, the greatest influence within the zero-point field of any local region of space will be caused by closest gravitational body in the vicinity.

The zero-point field can also be used to illuminate why Einstein called the warping of spacetime a “curvature” of spacetime. If the density of zero-points of the zero-point field is imagined around a single gravitational body, the zero-points will be seen to become less dense in a spherical fashion with increasing distance from the object. The way in which the zero-points could be envisioned to become less dense spherically around a gravitational body gives a view of how exactly spacetime is curved around gravitational bodies.

This can also aid in envisioning how light is bent around objects of mass is gravitational lensing. Because the zero-points represent standard space-time intervals, they also represent geodesics in spacetime. Because light travels from geodesic to geodesic in spacetime, it will be influenced by the gradient in the zero-point field and be bent toward denser spacetime as it travels through it. Thus, the effect of gravitational lensing, which was originally a proof of general relativity, can also be considered a proof of space density relativity.

With the concept of space density gradients, a far more defining explanation for the fluid distortion of spacetime by gravitational bodies has been attained that the previously vague description of some type of “warping” or “curvature” of spacetime. The movement of massive bodies in space continually causes the spacetime around them to become relatively denser, as has been illustrated with the spacing of zero-points on the zero-point field. This has allowed for a more detailed explanation of the perpetual interaction between gravitational bodies, spacetime, and the fermions that compose matter.

In the next section, the idea of space density gradients is reflected upon considering the reciprocal nature of spacetime. One could also imagine spacetime with the view that it varies in relative time density, rather than relative space density. To show this view of relative variance in time density, one can use the zero-points of the zero-point field once again, but this time with the zero-points representing the relative density of time. This is how things might be viewed with a Euclidean space perspective, providing an alternate representation of the actions of gravity as opposed to the length contraction explanation that has been derived thus far. In reality, both explanations can be used to envision the cause of gravitation, because length contraction and time dilation are reciprocal sides of the same coin considering the strict nature of space and time being bonded together as spacetime.

VII. TIME-SPACE RELATIVITY

As Einstein postulated, space and time are so interrelated that the two cannot really be separated from one another. This created a different view from the general idea that space and time are completely separate things. In this section, a different look from the standard view of the difference between time-like or space-like intervals is used to illuminate an interesting result of considering that the relativity of space density can also apply to the relativity of time density, within the more proper understanding of spacetime density relativity.

Spacetime density relativity must also explain that spacetime varies in a way that where space is relatively denser, time is also relatively denser. From the observed effect of time dilation near to gravitational bodies, it can be concluded that relative time dilation is synonymous with relative time density—where "denser" spacetime means a relatively slower rate of time. In this way, time density and space density are covariant, further exemplifying how space-time is one thing rather than two separate entities.

To conceptualize how this time component of spacetime varies relatively, the traditional view of Euclidean space can be assumed except with a slight change: Rather than the general ideology that is currently held in most minds where a Euclidean space is assumed with the idea that the rate of time varies relatively, for this view a Euclidean space will be assumed with the idea that it is the density of time that varies relatively. To illustrate this, the zero-points of the zero-point field can be used as time-like, to show that in a spacetime density gradient, there is also a gradient in the relative density of time.

For this, the invariant background will not be referred to so that the effect of length contraction will not be seen, and instead the coin will be flipped to the opposite side so that the time element of spacetime density relativity can be viewed independently. As already noted, to do this the zero-points of the zero-point field can be replaced as time-like points instead of space-like points, so that the distortion of spacetime around gravitational bodies will be seen as time becoming denser rather than space becoming denser—though, in reality, both length contraction and time dilation occur together. This is depicted in Figure 7.1, with a fermion's wavefunction being depicted without length contraction to represent it in a time density gradient.

Fermion in Time Density Gradient

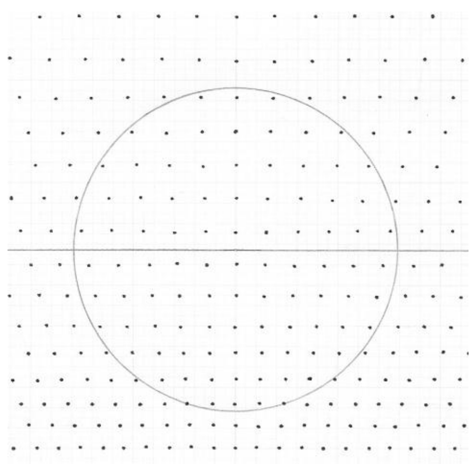

Figure 7.1: This depicts a fermion's wavefunction in Euclidean view of space, with zero-points representing time-like points to show a time density gradient. The gradient here shows the distribution of time density making the bottom half of the particle's wavefunction contain more time points than the upper half. This can be interpreted to be what steadily draws the fermion downward with the passing of time as the source of the force of gravitation.

As shown in Figure 7.1, when a fermion is viewed without the invariant background, so that length contraction is not seen, it becomes apparent that the lower portion of the particle is in more dense time. This is a means of representing the time dilation gradient across the particle, which can also be theorized as the cause of gravitation. If one considers that there is equal probability to observe the fermion as a point particle at every zero-point within the fermion's spherical wavefunction that is its Higgs occupancy diameter, it would be determined that it would be more probable to find the particle in the lower half of the wavefunction, because there are more zero-points in the lower half.

Considering this effect of the gradient in time, it becomes more probable that the quantum distribution of the fermion's energy in its Higgs field occupancy wavefunction will be in the side towards the denser spacetime. This can be interpreted to by why the particle will naturally be displaced toward the denser spacetime in a spacetime density gradient with the passing of time. This naturally results in continuous acceleration of all fermions toward the denser spacetime.

In a stronger gravitational field, and thus a steeper spacetime gradient, the distribution of zero-points will be more unequal between the halves of the particle, creating a more intense probability ratio between the top and the bottom of the fermion, thus resulting in stronger gravitation with the passing of time. This can be used to clearly explain why in a stronger spacetime density gradient, all fermions will be accelerated faster, which will be observable as a faster gravitational acceleration of freefall.

In the case that a fermion is prevented from moving down in the gradient with the passing of time, as it naturally would in freefall due to this correspondence with spacetime, its continual attempt to will cause the constant downward force known as gravitational weight. Furthermore, if a fermion has a larger Higgs diameter, there will be greater difference in time zero-point density between the top and the bottom of the fermion within the same time density gradient, and thus it will have greater weight. Therefore, the Higgs diameter of a fermion still accounts for its particular gravitational mass by this explanation.

By this, it has been shown how time density relativity provides an alternative description for the cause of gravitational acceleration and weight. This means that spacetime density relativity can be understood as the cause of gravitation from whichever side of the coin of spacetime is viewed. Therefore, time density relativity and space density relativity are reciprocals of the same characteristic of spacetime density relativity. This interchangeable viewpoint explains the title of this section.

It is interesting that this explanation for gravitation from the view of time density gradients makes it especially clear that gravity is caused by the mere passing of time. Thus, it becomes especially apparent from this view that gravitation is not really a force at all, but rather simply a result of the gradients caused by the relatively variant distribution of spacetime in combination with the space-occupying nature of the wavefunctions of particles having rest mass—or the Higgs field occupancy diameters of fermions, as defined in this text.

In other words, due to particles with rest mass occupying spacetime—as explained by the principle of Higgs field occupancy—they are naturally displaced toward denser spacetime as their natural course dictated by spacetime density gradients. This should serve to clarify that gravity is what one would call a “fictitious force” having nothing to do with force carrier particles like the other forces. In this text, explanation has been given as to how gravitational acceleration is carried out without a force carrier such as a graviton.

Now, when examining the idea of spacetime density, a question about the speed of light in differing spacetime densities is bound to arise. When considering how the variability of spacetime density affects the speed of light, it would seem that increased spacetime density should slow the propagation of light through that area relatively. This effect has actually been found by experimentation to be true and considered a proof of general relativity, in an effect called the Shapiro delay.

The Shapiro delay is explained in the terms of spacetime density relativity as the effect caused by increased spacetime density—that light traveling through a region of increased space density also travels through increased time density, slowing it comparatively to a light wave traveling the same distance through a region of relatively less dense spacetime. This can be explained in terms of spacetime density by considering that where space is denser, time must pass relatively slower so that the speed of light will remain consistent, as has already been briefly mentioned above.

As the reader is beginning to see, every prediction of general relativity is shared with space density relativity, aside from some particular unaccounted for details which are discussed in *Applications of Space Density Relativity*. Though things like time dilation and gravitational lensing are not new experimental predictions, they are experimental predictions nonetheless and must at least be considered as supporting evidence to spacetime density relativity. These, as well as several unique predictions from the principle of Higgs field occupancy, are discussed further after the following section.

For now, there will be a slight change of gears for the consideration of inertia. It has already been described that Higgs field occupancy by fermions is what gives them gravitational mass, but further consideration is needed to explain inertial mass. The concept of zero-points that was used in this section will play a useful part in describing how the Higgs field occupancy diameters of individual fermions also explains the quantum origin of inertial mass. This will be explained as that all fermions preserve their interaction with spacetime through their property of Higgs field occupancy.

VIII. QUANTUM INERTIA

When considering the basis of mass, it must be assumed that gravitational mass and inertial mass must be resultant from the same intrinsic property—and thus, they should be accounted for by the same theory. As such, the principle of Higgs field occupancy which gives fermions gravitational mass should also be applicable to inertial frames to account for inertial mass. When the Higgs diameters of fermions are included in the comparison of fermions in inertial frames which are in motion relative to one another, while keeping in consideration that the same laws must apply for all observers in all frames of reference, a reasonable explanation for inertia from the quantum level arises.

The property of Higgs field occupancy, in which all particles with rest mast have wavefunctions that span a finite amount of spacetime, is what makes it possible for particles to possess inertia, because it is what gives a fermion its relation with spacetime which it can then consider at rest. So long as the fermion is undisturbed, it will keep its same relationship with spacetime, considering its motion at rest and all other relative velocities in motion.

To get a view of how this works, the conception of zero-points within a particle's Higgs diameter can be used to show how fermions relate to different inertial reference frames. In Figure 8.1 below, the use of the idea of zero-points is applied to represent the differential effect between the forward side and the rearward side of a fermion having velocity relative to the inertial reference frame of the observer. For simplicity, the fermion in Figure 8.1 is depicted to have velocity perpendicular to the observer, with motion in the plane of the page relative to the reference frame of the observer viewing the diagram.

Fermion with Relative Velocity

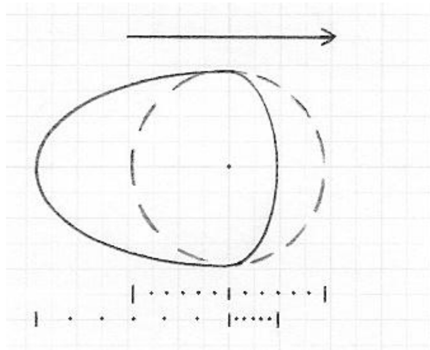

Figure 8.1: The dashed line of the circle represents how the wavefunction of fermion would appear to the observer if it were in the same inertial reference frame of the observer. The solid line representing the wavefunction of the fermion is skewed due to the relative difference caused by the fermion having relative velocity to the observer (which is perpendicular to the observer viewing the diagram in this case). The zero-points depicted below the fermion's wavefunction indicate the relative difference in the relation with spacetime between the fermion's inertial reference frame and the reference frame of the observer. The upper row of dots under the particle show where the zero-points would be for things in the observer's frame of reference, while the lower row of dots shows how the zero-points are distorted relatively for the inertial frame of the fermion in motion relative to the observer's frame of reference. This relative difference in the fermion's relationship with spacetime can be observed in the Doppler shift: One in a co-moving reference frame with the fermion would therefore see blueshifting of light in the forward direction (right in the diagram) and redshifting of light in the rearward direction (left in the diagram) from light of objects in the reference frame shared with the observer of the diagram.

The same effect shown by Figure 8.1 can be applied to all directions of motion by imagining the same effect for all possible vectors of motion in which there is relative velocity between the observer and any particular fermion. The depicted relative shifting—with space-time intervals in the forward direction being shortened relatively and space-time intervals in the reward direction being lengthened relatively—for all fermions with velocity relative to their surroundings is therefore explained to originate in the difference between the fermion's particular relationship with spacetime (which it can consider to be at rest, with its wavefunction always spherical in its own reference frame) compared to the relationship with spacetime observed from the reference frame of the surroundings.

This difference in the opposing inertial frames of reference is therefore the cause of their viewpoints of space-time intervals to be distorted relative to one another, though the Lorentz invariance is kept at all times between the respective frames. Through this, it is apparent that this explanation of quantum inertia represents how reference frames in motion relative to one another are applied to the quantum scale for individual fermions in different frames of reference.

Such a representation as given in Figure 8.1 cannot be applied to massless bosons for reason that they do not possess the property of Higgs field occupancy. This can also be considered to be explanation for the fact that fermions cannot travel at the speed of light. If the fermion were to travel at the speed of light, the forward separation in space-time intervals would become zero, and the rearward separation in spacetime intervals would become stretched to infinite, which would break the Higgs field occupancy diameter and essentially mean the destruction of the fermion. This is why only bosons such as photons with no rest mass and therefore no Higgs diameter—thus rightly considered as either waves or particles of truly zero size—can travel at the speed of light.

To explain the degree to which there will be distortion forward and backward, the effect will be proportionally based on the relative velocity between the inertial frames. For example, if the fermion is moving with 50% the speed of light relative to the observer's frame, there should be a 50% contraction of space-time intervals in the direction of motion and a reciprocal 200% lengthening of the space-time intervals in the direction opposite of motion relative to the observer's reference frame.

This is how the relative difference between inertial frames of reference is the origin of Doppler shifting of the apparent wavelength of light between reference frames, accounting for the redshift that is seen from light in the direction opposite of the motion and the blueshift that is seen in light from the forward direction of motion in the surroundings which have relative velocity different from that of the observer. This respective Doppler redshifting and blueshifting of light caused by the difference in inertial frames of reference goes away if the frame of reference of the fermion is brought into the same inertial frame as its surroundings. The force that is required to bring that relative change in the inertial reference frame of the fermion is considered to offset the inertial "force" that resists change in relative motion. However, this inertial tendency for fermions with Higgs occupancy diameters to preserve their motion is not a true force, as change to it must always be carried out by means of the forces governed by boson force carriers.

The relative distortion between inertial frames does not reflect any actual misshaping of the particle, but is rather only an observed effect caused by having differing inertial frames of reference. The degree of distortion between the two frames will be directly related to the difference in velocity between the two inertial frames. And the greater the relative velocity a fermion has relative to another frame of reference, the greater the difference in its relationship with spacetime will be, so more force will be required to bring it into that other inertial reference frame. Likewise, if a fermion has a larger Higgs diameter, it will take more force to change its inertia because it has more relationship with spacetime through its increased amount of Higgs field occupancy.

From this, the different inertial masses of different fermions have been explained to be derived from the Higgs diameter of the fermions, which relates directly to each fermion's energy content. Because heavier fermions have more energy content, they occupy more Higgs field, and thus they have more relation with spacetime, which has now been illuminated as the origin of inertial mass. Therefore, as predicted, the standard of Higgs field occupancy is what gives fermions both their gravitational mass and inertial mass.

From this, it can be concluded that the inertial mass of any object is equal to the sum of all of the sub-atomic particles' Higgs diameters within it. This will be the factor that determines the amount of force it will take to change the relative velocity of that object, or in other words to accelerate it. This has therefore been an independent derivation of Newton's equation $F = ma$ from the quantum scale.

In summary, now that both quantum gravitation and inertia have been accounted for by the same property, the individual effects of both can be compared. This can be done by comparing the effects on the Higgs field occupancy diameters of fermions by both space density relativity and quantum inertia. The gravitational acceleration of a fermion can be depicted by the length contraction on its Higgs diameter by a space density gradient, while the inertia of the fermion can be represented by the relative difference in its Higgs diameter.

Because the Higgs diameters of particles are the determining factor in both their gravitational mass and inertial mass, they can be compared side by side to show the combined explanations of quantum mass together in one figure. This is done in Figure 8.2 below, which depicts the effect of relative inertial motion and a space density gradient on two particles of differing mass. This shows how a larger Higgs diameter will result in more inertia with the same amount of amount of velocity and more gravitation in the same space density gradient, therefore giving visual representation for why heavier particles have more inertia at the same velocity and more weight in the same gravitational field.

Effect of Velocity and Gravitation on Particles of Differing Mass

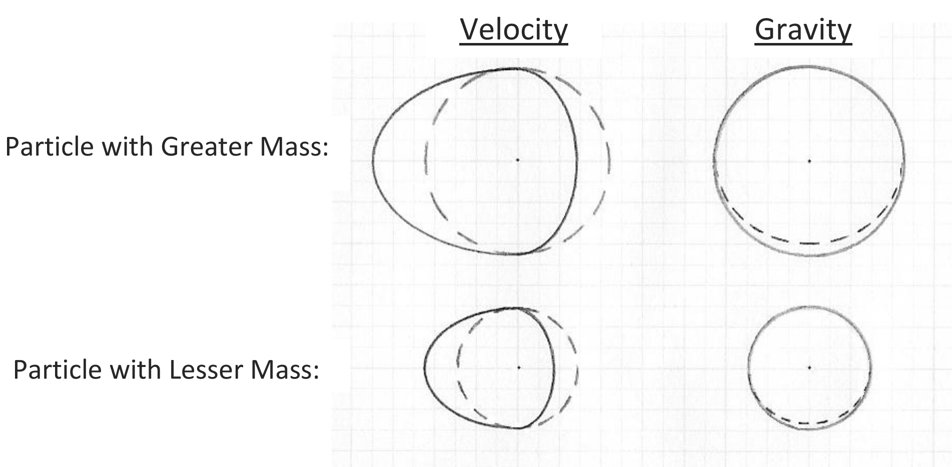

Figure 8.2: This figure depicts inertial and gravitational effects on two particles having differing rest masses. The particle in the two representations in the top row has a larger Higgs diameter than the particle in the two representations in the bottom row. The left column represents equal relative velocity on the two particles and the right column represents the effects of an equal space density gradient. Though the two particles have the same velocity (left), the larger particle has more difference between its resting state (indicated by the dashed line) and the distortion of its relative relationship with spacetime caused by having velocity relative to the observer's reference frame (indicated by the solid line) and thus more inertia. Similarly, though both particles are under equal gravitational acceleration (right), the larger particle undergoes more total length contraction (indicated by the dashed line) and thus has more weight. This figure can be said to represent a quantum account for the equivalence principle provided by Higgs field occupancy.

As shown in Figure 8.2, Higgs field occupancy defines the underlying mechanism for the rest mass of any particle. For both inertial mass and (passive) gravitational mass, the particle's Higgs diameter is the determining factor, making the inertial mass and (passive) gravitational mass of any particle always equivalent. It follows simply through inductive reasoning that this is the origin of the equivalence principle for all objects, as both masses for any object will be the combined sum of all the sub-atomic particles' Higgs diameters in the matter composing that object. This account for quantum mass was realized by applying the properties of quantum mechanics to the ideology of "point particles" to see that particles with rest mass (fermions, as defined for this text) can have non-zero size via their wavefunctions, though they are observed as point particles when directly observed.

Finally, the interpretation of all the above is that the theories of Higgs field occupancy and space density relative together provide grounds for explaining the origin of mass, the source of inertia, and the cause of gravity. This was all made possible by taking a refreshing new look at the old dogmatic ideas regarding quantum mechanics and general relativity, which is what was apparently needed to understand these most basic and first recognized "forces", which had up till now intriguingly remained the most open to speculation.

Beyond these theories merely providing theoretical explanations for observed phenomena, they also give experimental predictions that can be tested physically as proof of them. Of course, the existence of gravitation and inertia would be the initial proofs of these theories, but more specific experimental predictions are discussed in the next section.

IX. EXPERIMENTAL PREDICTIONS

It is understood that for a scientific theory to be legitimate, it must provide testable predictions which can be falsified or confirmed. The theories of space density relativity and Higgs field occupancy make a wide range of testable predictions. This, needless to say, is a considerable advantage for these theories as compared to the status quo theories attempting to synthesize quantum gravity.

First off, a few of the previously mentioned experiments that have already been conducted for general relativity which can be considered as tests of space density relativity will be briefly discussed. In addition to these, a preview for the predictions from space density theory regarding “dark energy” and “dark matter” that are discussed in more detail in *Applications of Space Density Relativity* will be given. Then some new predictions regarding gravitation will be proposed for spacetime density relativity. And lastly, some unique predictions will be provided to test the principle of Higgs field occupancy.

Perhaps the easiest observational test which provides evidence for spacetime density relativity is the deflection of light toward objects of mass in gravitational lensing, as has already been mentioned. Likewise, it has already been discussed how the Shapiro delay can also be considered an experimental prediction of spacetime density relativity which has already been proven. Moreover, gravitational time dilation itself could also be considered experimental evidence for spacetime density relativity, as well as the black holes and the expanding universe predicted by general relativity, because space density relativity for the most part fills in the details of the theory for how general relativity actually works.

An experimental prediction of general relativity that has not yet been explained for spacetime density relativity in this document is gravitational redshift. Gravitational redshift can be explained with space density relativity through the use of the concept of the zero-point field as it was considered for a time density gradient. When a light wave travels away from a gravitational body into less dense spacetime, the wavelength of the light will begin to appear slightly lengthened due to the relatively decreased time density. This is, in fact, a more accurate description for the cause of gravitational redshift that the light losing energy from climbing out of a gravitational gradient. Of course, the reverse happens when a light wave travels into an area of increased time density with the wavelength appearing relatively shorter due the relatively increased time density, though the light does not actually gain any energy. In other words, the light does not actually lose and gain energy in traveling into regions of relatively different spacetime density, but rather the apparent frequency of the light merely appears to change because of the relative difference in the local rate of time.

A similar, but slightly different effect can be considered for the experimental observations in the wavelength of light from distant supernovae that has been interpreted to suggest that the rate of expansion of the universe is accelerating. When considering the fact that the light from distant supernovae is slightly less redshifted than would be expected, it must be considered that the spacetime in which that light was emitted was relatively denser in the distant past when spacetime was relatively denser than it is today. As discussed in *Applications of Space Density Relativity*, when this factor is accounted for, it should be found that the rate of expansion truly was faster in the past, but that the light emitted then started out relatively shortened and thus its wavelength is not redshifted as much as would be expected had it started out in today's decreased relative spacetime density.

Another factor discussed in *Applications of Space Density Relativity* has to do with the observational evidence that has currently been attributed to “dark matter”. The observations of increased orbital speeds toward the edge of galaxies in galactic rotation curves and increased gravitational lensing around galaxy clusters can be explained to actually be predictions of a factor of space density relativity. In these cases, it will be explained that the factor of the background spacetime density must be taken into consideration. The effect of the relatively decreased background spacetime density “behind” galaxies compared to the local background spacetime density here around the Earth will result in increased spacetime density gradients being formed, and thus there will be an observed increase in gravitational acceleration toward the edge of galaxies and increased gravitational lensing around galaxy clusters to go along with these increased space density gradients caused by the same amount of energy present, due to what can be called the *background density effect*. This is proposed as an explanation for the observations attributed to dark matter, rather than assuming there must be some extra invisible matter present to account for the observations.

The background density effect can be used to make some new predictions for gravitation regarding spacetime density relativity that should be currently testable. If one were to make a device to measure the gravitational attraction between two objects (the conceptualization of which could be inspired by parts of the Cavendish experiment), they could use it to measure the force between the two objects in areas of differing background spacetime density and then compare them. In accordance with the background density effect proposed here and further discussed in *Applications of Space Density Relativity*, it would be predicted that there will be increase gravitational force between two objects of the same mass at the same distance in a region of lower background spacetime density.

If a device were created to measure the precise gravitational force between two objects here within the locally increased spacetime around the Earth and then that device (or one identical in composition) were sent away from the Earth into a region of relatively less dense background spacetime, it should be found that there will be stronger gravitational force observed there. This increased gravitational effect would be explained to be due to the fact that the intensity of the spacetime density gradient created around an object of mass has to do with to the background density of the spacetime in which that object is immersed. More on this, including how the effects of this should be interpreted in regard to the gravitational constant, is discussed in *Applications of Space Density Theory*.

Now, having discussed the predictions regarding the theory of space density relativity, some possible experimental predictions of the theory of Higgs field occupancy can be proposed—though they will admittedly be much more difficult to detect due to their miniscule and quantum nature. Remember, Higgs field occupancy is given as an explanation for the phenomenon of particles having rest mass. According to the theory, the only way for a particle to have inertia or to be gravitationally accelerated via space density gradient is for that particle to have a finite, non-zero size. However, this finite size of the particle is not size in the sense of a classical body, but the rather refers to the given amount of area of Higgs field occupied by the particle's resting wavefunction. The size of this wavefunction, as has already been discussed extensively, is deemed the particle's Higgs diameter which should determine the inertial and (passive) gravitational mass for any particle.

The Higgs diameter of any individual particle—elementary or composite—should correlate directly to the amount of energy contained in the particle, and because the particle's energy is the equivalent of its mass, the Higgs diameter of the particle should also directly correlate to the particle's rest mass. Applying this, it should be predicted that each type of particle found to have a certain rest mass should also be found to have a certain expected Higgs diameter, according to the theory of Higgs field occupancy. For instance, each type of quark should have its own standard Higgs diameter, which should be calculable by its mass and theoretically measurable.

I will attempt here to derive how the Higgs diameter theory could be experimentally tested. To begin with, the experiment would have to be applied to a particle which can have only one inertial frame (as opposed to a particle like an electron in an atomic orbital which can have any one of many possible velocities and inertial frame), as we have previously discussed. It would be simplest to have the particle at rest in the observer's co-moving inertial frame. From what is known of the uncertainty principle, measuring the particle's size while knowing its velocity will be tricky. If measuring the particle's diameter requires measuring the particle's location, the velocity of the particle cannot be measured at that same instant. Thus, to set up a means of knowing both the particle's velocity and its location, we must find a way to make a particle have one constant velocity, which can be known for a time without directly measuring it. If that is done, we should be able to measure the particle to determine its size, simultaneously knowing both the particle's location and velocity *de facto*.

I can propose a possible experiment here to do this, which includes isolating a particle with magnetic charge—obviously requiring a particle with charge that can exist individually without decaying too quickly—and then placing it into the center of a sphere of magnets which can produce a magnetic field which is nearly perfectly uniform in shape. The particle would be forced to the precise center of such a structure where the magnetic fields converge. Given a constantly continuous magnetic field with little to no fluctuation, the particle ought to stay perfectly still at the precise center of the magnetic fields. The velocity of the particle would then be known without measuring it, because it is physically forced to remain still in that one location. This would satisfy the requirement of having a particle at rest within one inertial frame and thus know its velocity without directly measuring it.

After isolating and stabilizing a particle as such, a detection device would be used to detect the exact location of the particle with photons. We could use a detection device that fires photons individually near to the precise center of the sphere. By detecting the exact location at which the photon is emitted and received individually, it should be possible to tell if the photon collided with anything in its flight. Of course, this experiment would have to be in a vacuum so that it would be known that the photon hit the particle of interest. In the event that the photon was not received where it should have been if undisturbed, it must be assumed that the photon collided with the particle. This would be deemed from the photon not hitting the receiver it should if it were to have travelled a straight, unimpeded path.

In the instances where the photon collided with the particle, it would have to occur at one point in space. The interesting part of quantum mechanics, of course, is that prior to the photon hitting the particle, the particle did not exist at any one place. Rather, it was in the form of a wavefunction of possible locations. In the case that the photon collides with the particle, the wavefunction collapses, forcing the particle to be in one location at one instant, and hence appear as a point particle. We can infer that there would have to have been probability for the particle to be located it that point prior to the particle being observed. Therefore, the wavefunction of the particle would have had to have existed in that place prior to the particle being located there, though the particle did not exist there as a solid object in the classical sense.

To measure the size of the wavefunction, the individual firing photons would be fired increasingly closer to the exact center location of the magnetic field, slowly honing in on the area in which the particle must exist. This would be repeated, with the expected path of the photon being directed closer and closer to the precise center of the sphere until the photon was not received where expected and thus assumed to have hit the particle's wavefunction and collapsed it in a collision with the particle. The instances in which the photon was not received where expected had it not been interfered with would be totaled, and a composite picture of the wavefunction of the particle could be derived.

All of the locations where the photons collided with the particle would be mapped to show the diameter of the particle's Higgs field occupancy. This map should eventually form a spherical pattern (if the above process were completed in a spherical formation, or a circular pattern if it were more simply performed in just one plane) in which the particle's wavefunction existed prior to collapsing from collision by the photon. The diameter of this sphere (or circle if in one plane) of instances would then represent that particle's Higgs field occupancy diameter. By making this composite map for different particles—a proton and an electron would probably be easiest—the different particles' Higgs diameters could be compared and related to their expected rest mass as a test of this theory for the quantum origin of mass.

In this way—and plausibly others—it should be theoretically possible to measure the Higgs diameters of particles of differing rest mass and to then compare the results. Now, considering the extremely minute scale, this experimentation would be immensely difficult. Still, considering such apparatuses of particle colliders and dark matter detectors, such an experiment should be feasible. If the Higgs diameters of at least two different fermions with known standard mass were consistently measured and then compared, their mass-diameter relationship would be an experimental test of the principle of Higgs field occupancy. Thus, this theory has given an experimentally testable hypothesis, making it a testable theory.

One possible caveat could be given regarding composite fermions in this experiment. It is a possibility that has been considered that the origin of mass in composite fermions is different from the origin of mass for elementary fermions. This would mean that there might not be a direct correlation between the Higgs diameter of elementary fermions and the Higgs diameters of composite fermions, though there is a certain prediction that this theory will predict different diameters for the elementary particles according to their masses. This consideration includes other possible explanations for composite particle mass such as that provided by the calculations of quantum chronodynamics (QCD). However, it would seem more likely that Einstein's $E = mc^2$ would account for the rest mass of all fermions in the same way. Again, "fermion" is defined herein as any particle of matter that can be considered as one whole unto itself. By these means, composite fermions including all hadrons should be valid for comparison with all elementary fermions, due to their individual existence in which their internal characteristics are concealed to all their interactions.

There will be a difference, however, between elementary and composite particles for explanation of collapsing the wavefunction. Where an elementary particle will entirely collapse to one point particle when detected, a composite particle such as a baryon could be considered to have the wavefunction of one of its quarks located in the single detections described in the experiment proposed above. If the photon were to collide with a proton, for example, it not collapse the whole proton to a point particle upon photon collision like an elementary particle would, but rather several particular different types of interactions could occur. Regardless of what type of interaction occurred, for the above experiment, any time the photon was not received where expected if it where undisturbed, interacted with the proton as a whole could be inferred, and thus the wavefunction of the proton would be observed. So, the composite picture formed by the above described experiment for any hadron composed of individual quarks in wavefunction prior to detection would make a composite picture of the total hadron's Higgs occupancy diameter when considered as an individual particle. Therefore, by the understanding of particles and their rest mass that has been depicted in this document, the total rest mass of any hadron will be best described to originate from the conglomerate wavefunction within which the individual wavefunctions of each quark and gluon disappears while combined as one whole.

An example of an experimental finding which can be explained to support this is the occurrence that when nucleons bind with other nucleons through the residual nuclear force in atomic nuclei, there is a reduction in each nucleon's mass contribution. This must be due to the nucleons having smaller Higgs diameters when surrounded by other nucleons. This finding would be harder to explain if the origin of mass for these composite fermions was theorized to be derived from the summed contributions of the quarks and gluons within each nucleon.

To explain this, one can remember the discussion of imagining each nucleon as a triangle of three quarks connected with gluons with quantum mechanics is applied to form one larger spherical wavefunction, in which all possible orientations of the triangle exist. When nucleons are residually bonded together in a nucleus by the residual strong force, it allows the quarks in each nucleon to pose slightly closer together. This, in effect, makes the diameters of each nucleon smaller. By this the decrease in the mass contribution of each nucleon is explained. This can be called the hard postulate of Higgs field occupancy, in which the rest mass of an object is strictly accounted for by the combinations of each of the Higgs diameters of its particles.

This alludes to the fact that there must be a soft postulate of the Higgs field occupancy account for mass. This soft postulate applies to such issues as that the absorption of radiation by a body will result in an increase in that body's total energy, and therefore an increase in its total mass, though this increase is not accounted for in the increase of any particle's Higgs diameter. This must mean that the rest mass of a system is not necessarily constant with the exact combination of each of the contributing particles' Higgs occupancy diameters—since the total mass of a body can somehow increase without the direct increase in any Higgs diameter or addition of more particles.

This means that, when considering the mass of systems of particles, the soft postulate of Higgs field occupancy must be used. In the soft postulate, the total mass in the system may differ from the sum of all the fermions' Higgs diameters. With the soft postulate—which will be found to be paramount to the hard postulate for any real-world setting—the entire energy in a macro-scale object can be considered to have a *total Higgs field occupancy equivalency* which includes the total energy equivalence in the object's total mass. In this, the total Higgs field occupancy equivalency for a body could be considered to be the diameter an imaginary particle would have if it were to hold the entire energy equivalence of that body. An example where this must be considered is in that of a transistor which can undergo increases and decreases in rest mass with increases and decreases in its stored energy.

A transistor, when charged, will have more total energy and thus a larger total Higgs occupancy equivalency than the very same transistor when uncharged. This is true despite the fact that there is no change in the Higgs diameters of any of the fermions which comprise the transistor. Therefore, this particular variance of the rest mass of the transistor requires the soft postulate of Higgs field occupancy. Another example for this would be that a compressed spring will have greater rest mass than the same spring when not compressed. This has to do with the fact that the total energy of a system, which can include other factors than just the constituent matter's mass contribution, must be accounted for in its rest mass. In other words, not all rest mass in objects comes directly from the rest mass of the particles that compose it. Thus, it is impossible to account for all of the rest mass in total systems by the hard postulate regarding quantum origin of mass proposed by the theory of Higgs field occupancy alone without invoking the soft postulate which covers other contributions, such as the energy contribution of photons, when contained into larger systems which can be considered to be at rest. Nonetheless, the hard postulate of Higgs field occupancy for individual fermions provides a better understanding for the origin of mass than has yet been attained by any other theory.

Finally, the actions of gravitational acceleration can be declared to be an experimental prediction of the combination of space density relativity with Higgs field occupancy. Of course, more precise predictions than that will be expected. Regarding this, some formulations can be yielded for quantum gravity when Higgs field occupancy is integrated into space density relativity. Basically, quantum gravitation is a function of each particle's Higgs occupancy diameter and the local spacetime density gradient in which it lies. In this, the local space density gradient is always responsible for the direction and rate of acceleration by gravity, while the Higgs field occupancy diameter of the particle is what determines the amount of force the particle receives from the gradient. Therefore, the force of gravity on any fermion is the product of the particle's Higgs diameter and the space density gradient in which the particle is located. This force will always be applied in the direction of the greatest difference in spacetime density across the particle's diameter.

To reiterate, the theorization provided in this document predicts that the force of gravity on any particle can be calculated by multiplying the particle’s Higgs field occupancy diameter (which is determined by its resting energy content, or rest mass) by the local spacetime density gradient in which it exists (which determines the gravitational acceleration by spacetime). As far as our means of calculating the local spacetime density gradient, the most practical experimental application would be to measure the rate of time with clocks in differing locations to derive the local gradient in the rate of time, since it is impossible to measure the relative length contraction of a spacetime density gradient. The gradient in relative spacetime density derived from the difference in the rate of time can then be applied to the measured diameter of a fermion within that gradient to find the differential in relative spacetime density between the top and bottom of the fermion, from which the weight of the particle will be predicted.

From this, the gravitational force on any particle can be reduced to the relative difference in spacetime density across its Higgs diameter. The values produced from equations derived from this formulation (the mathematics of which remains to be completed by physicists, though Einstein’s field equations should be found to already describe spacetime density gradients) could be compared against the observed weights of differing particles in one gravitational field, or the observed weight of the same particles in differing gravitational fields, to test this experimental prediction. If observational measurements are found to be accurately predicted by these calculations, it would give fundamental confirmation for these two theories as the quantum source of gravity.

X. CONCLUSIONS

The opening thought experiment of this work was taken from one that Einstein used in his general theory of relativity to show that the geometry of spacetime is not Euclidian. The full implications of that thought experiment, including the true existence of length contraction in spacetime, have been applied in this text's explanation that the "warping" or "curvature" of spacetime away from Euclidian is rightly described by the relativity of spacetime density in which spacetime density gradients manifest as gravitational fields around objects of mass.

Developing an understanding of this relative varying contraction of spacetime led to a visual representation of spacetime density by the aid of the concept of an invariant background that does not contract relatively with spacetime according to the distribution of energy within it, which helped in the conceptualization of units of space and the zero-point field. With the invariant background to refer to, the length contraction effect on individual particles was analyzed to show how space density gradients are the effectual cause of gravitation. And time density gradients were also shown to be understandable as the cause of gravitation, once individual fermions were understood to have wavefunctions of non-zero size that occupy a certain amount of the Higgs field in spacetime.

The amount of Higgs field that a particle occupies was further discussed and understood to be what gives each fermion their inertial and gravitational mass. Finally, an understanding of gravitation from the quantum scale was clarified to be the result of the Higgs field occupancy of particles with rest mass existing in spacetime density gradients and experimental predictions were provided regarding these theorizations.

In addition to explaining the topology of spacetime described by Einstein's general relativity and the origin of Newton's laws of motion from the quantum scale, the culmination of this work pertaining to quantum gravitation can be drawn about by comparing and contrasting the old view of Newtonian gravity and the new view of quantum gravity, as is shown in the following set of word equations:

Newtonian Gravity

mass x acceleration of local gravity = gravitational force on the body of mass

- as derived in Newton's $f = G\,(m^1 m^2/r^2)$.

Quantum Gravity

Higgs diameter of particle [*the particle's rest mass*] x local space density gradient [*determines the acceleration*] = gravitational force on the particle

Precise Quantum Gravity

Δ spacetime density across the particle's Higgs diameter [*includes the mass of the particle and the spacetime density gradient*] = force of quantum gravity

*In more readily derivable terms:

Δ relative rate of time between the top and bottom of the particle's Higgs diameter = force of quantum gravity

- The difference in relative rate of time between top and bottom of the particle's diameter can be calculated using Einstein's field equations of general relativity (though it could theoretically be determined without the equations, as it could simply be measured with clocks).

And thus, the force of quantum gravity can be derived for any individual particle with rest mass in any region in spacetime, as a function of the particle's Higgs diameter and the local space density gradient in which it exists. It is significant to note here that it is absolutely clear in this description of quantum gravity that objects do not technically have "gravitational pull" on one another through a gravitating boson. Rather, they are simply influenced by the spacetime in which they exist, while also influencing the spacetime around themselves—as described by Einstein and defined in his field equations of general relativity.

In fact, it is not even necessary to know the masses of the gravitating body and the particle involved to predict the acceleration of gravity, though such details are nice to have for input into Einstein's equations. The acceleration of a gravitational field could be predicted simply by measuring the difference in the rate of time across the field. With this known, the force that will be applied to any object could be derived simply from knowing its mass. More simply, for fermions, only the diameter of the particle would need to be known to predict how much force it would receive from the gravitational acceleration of that field. This gives a from-scratch approach to the essence of quantum gravitation with elegant simplicity.

In this, the explanation for quantum gravitation has been derived to be a true combination of what Einstein described about spacetime in his theory of general relativity and a renovation of the quantum mechanical understanding of the nature of particles. In this, an accordance of quantum mechanics with general relativity has finally been made, and it has produced the explanation for gravitation as expected. This description of quantum gravity nicely requires no unobserved boson. By these grounds, the gravitational force is not truly quantifiable and it is of no surprise that attempts to quantify it with the nonexistent graviton have been unsuccessful.

This explanation should be a great relief to the prolonged lack of progress toward a quantum understanding of gravity in theoretical physics. No less, the mechanism responsible for the characteristic of quantum inertia—which seemed to have been largely forgotten in theoretical physics as an unexplained fundamental action—has also been explained along the way. If this is to be the final theory of quantum gravity, as its widely encompassing nature surely seems to suggest, it should also aid in gaining understanding for many more unexplained physical phenomena in nature. This is found to be the case for things such as black holes and the Big Bang, the implications for which are described in a separate document that has already been alluded to several times, titled *Applications of Space Density Relativity*.

AFTERWARD FROM THE AUTHOR

It should be addressed that many parts of this theory are highly likely to be strongly protested by the status quo in the existing scientific community. Of the most blatant reason for this is that it does not provide any extremely complicated equations, which the search for quantum gravity has come to be centered around. However, it should be pointed out that the theory usually needs to come first for new breakthroughs in physics. It has been my hope that professional physicists who understand Einstein's field equations can apply their efforts to filling in the equations for the theory provided in this document now that it has been released, which will also go for the calculations needed regarding *Applications of Space Density Relativity*.

I would like to point out that the primary theory of the two presented here is Space Density Relativity, as is signified by the order in which they are stated in the title. I am noting this here to give notice to the fact that I am not as certain about the theory of Higgs Field Occupancy truly describing the quantum nature of particles as I am that space density relativity describes the true structure of spacetime.

For one thing, it is difficult to ascertain how Higgs field occupancy applies to particles in superposition. However, it is certain that particles in superposition are still affected by gravity, and thus the essence of some theory must still apply to them while they are in such states. The reason for bringing this up, in all honesty, is to note that if the quantum mechanics of particle Higgs diameters is false, it should not take away from space density relativity. Thus, I am explicitly stating that these two theories should be considered independently, as well as when combined, so that one is not thrown out with the other if one is found to be incorrect.

It is the property of Higgs field occupancy, however, that determines particle gravitation when incorporated into spacetime density relativity. So in the case that fermions are soundly proven to not possess wavefunctions when undisturbed that can be considered Higgs field occupancy diameters, the account for quantum gravity given here is lost. Nonetheless, so long as spacetime density relativity still holds, as I am sure it does, it alone should provide great benefit in understanding much about the nature of spacetime and the universe in which the current state of physics lacks sound explanation.

For example, as has already been touched on in this text, space density relativity ought to provide revolutionary revisions when integrated into many enigmatic experimental observations, such as those currently attributed to “dark energy” and “dark matter”. An understanding of space density relativity explains that the cause for these observations being misunderstood is that we did not yet have an accurate understanding of the structure of spacetime and gravitation to properly interpret them. A more detail discussion of these and other related subjects is provided in the now thoroughly introduced *Applications of Space Density Relativity*.