The Geometry of Spacetime and the Unification of the Electromagnetic, Gravitational and Strong Forces

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Abstract: In this paper, a spacetime structure consisting of a body-centered cubic lattice is modeled classically as a spring-mass system, where the components of each unit cell in the lattice are based on the fundamental units discovered by Max Planck, and the common forces that govern the motion of particles in spacetime is defined and unified by geometric shapes as the spacetime lattice oscillates.

Introduction

In the early 1900s, three-dimensional space and time were linked by Albert Einstein into what became known as a single word – spacetime – to describe the mathematics of relativity. Yet Einstein didn't describe the mechanism for the curving of spacetime nor how it bends and contorts to cause gravity [1]. Years prior to Einstein's work, Max Planck discovered and established a number of constants that simplify the mathematics of the universe – known as the Planck units – but he was not able to describe the meaning of these constants [2]. Here, the Planck units are applied as the fundamental units of length, mass and time to define the geometry of spacetime and explain the natural forces that cause the motion of particles within its domain. There is a reason that the Planck constants fit elegantly into equations that represent the energy and forces of the universe.

If spacetime is considered to be a structure that curves, the structure that is *curving* must be defined. Similarly, if particles and photons are considered to be wave-like, the structure that is *waving* must be defined. Here, the structure of spacetime at the smallest of levels – the quintessence of the universe – is proposed to be a material in a lattice structure of repeating unit cells, where each of the cells may vibrate in harmonic motion such as Fig. 1.

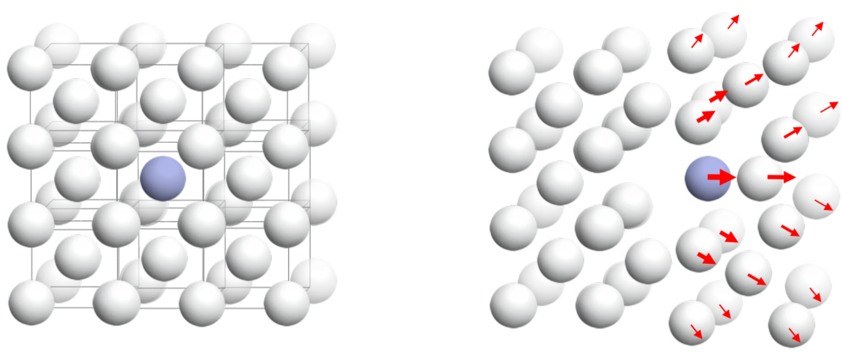

Fig. 1 – Spacetime lattice – no vibration (left); cascading effect of vibration (right)

This structure is responsible for the forces that cause the motion of particles, including the electric, magnetic, gravitational and strong forces. It is also responsible for the energies of photons and particles. Here, these forces, the energy of photons, and the energy of the electron will be derived and explained using only five total constants and the geometry of spacetime. Three of these constants (Planck length, Planck mass and Planck charge) are shown in the next figure to describe a unit cell of the spacetime lattice. It will also be shown that a unit cell exhibits behavior similar to a spring-mass system, and as a result, can be calculated using classical mechanics.

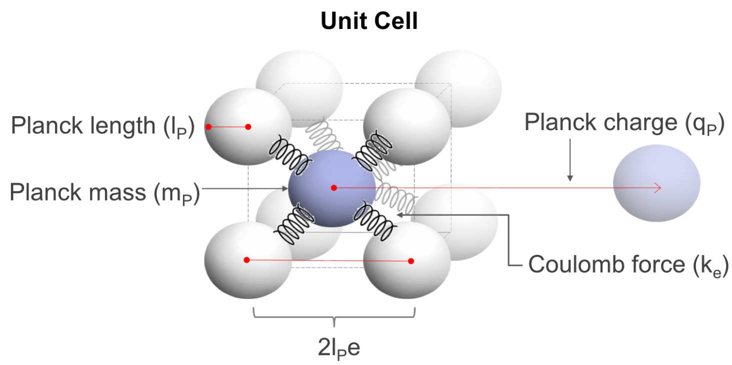

Fig. 2 – Spacetime unit cell

The process to define the unit cell began with a wholistic view of force and energy equations, which often have either mass or charge as variables. Using Modified Unit Analysis (MUA), these equations were first consolidated in units, by relating mass to charge. This was reported in the first of three papers that form the baseline for this paper – *The Relationship of Mass and Charge* [3]. The key finding was the exchange of the units of charge (Coulombs) to units of distance (meters) to relate these properties. Charge is defined here as the displacement distance of a unit cell. The remaining two papers that form the baseline of this paper also describe relationships – *The Relationship of the Mole and Charge* and *The Relationship of the Fine Structure Constant and Pi.* These papers define the separation distance of unit cells and the body-centered cubic structure of the spacetime lattice respectively [4, 5].

The purpose of this paper is to develop a framework for the underlying structure of the universe, so that it can be modeled with classical mechanics and simulated with computer programs to describe the energy and motion of subatomic particles. The paper first describes the basic unit system and how it is applied to the geometry of spacetime. Then, it offers proof of the calculations and unification of forces by deriving and explaining the fundamental physical constants that are used in force and energy equations and are known to match experimental evidence, such as the Coulomb constant (k_e) for electric forces or the gravitational constant (G) for gravity. More than a dozen fundamental physical constants are derived throughout this paper as such proof.

1. The Universe in Simplified Units (kg, m, s)

All of the equations for forces and energies can be simplified to three units for mass, distance and time. This forms the fundamental kg/m/s unit system. What Max Planck found naturally in the constants for Planck mass, Planck length and Planck time were tiny values when compared against these units in our human reference frame – one that had already been established for kilograms (kg), meters (m) and seconds (s) in our macro world. But the smallest unit cells of spacetime is orders of magnitude smaller. These Planck units form the reference point of an object that occupies the space at the center of the spacetime unit cell – hereafter referred to as a *granule.* Each granule has a mass of Planck mass (m_P), a radius of Planck length (l_P), and when in motion at a universal speed, it takes Planck time (t_P)

to travel one Planck length. The value of Planck mass is deceiving because it is significantly larger than the mass of the electron or proton, yet it occupies a much smaller space. It will be shown that the energy from this mass is only recognized when a granule is in motion.

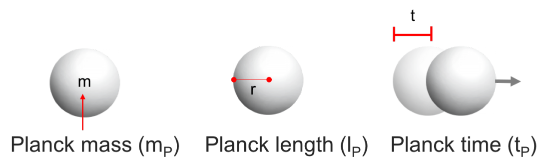

Fig. 1.1 – The basic Planck units for the kg/m/s unit system

The values for each of the basic Planck units are:

$$m_P = 2.17643 \cdot 10^{-8} \, (kg) \qquad \textbf{(1.1)}$$

$$l_P = 1.61625 \cdot 10^{-35} \, (m) \qquad \textbf{(1.2)}$$

$$t_P = 5.39125 \cdot 10^{-44} \, (s) \qquad \textbf{(1.3)}$$

The previous three Planck constants apply to the default units of mass, length and time. Two additional constants are required for the foundation of five constants that can derive everything in this paper. The remaining two constants are related to the electron: the Planck charge (q_P) is the granule displacement at the center of the electron, and the electron's classical radius (r_e) is the distance from the center of the electron where standing waves transition to traveling waves. Both will be described in further detail later in this paper.

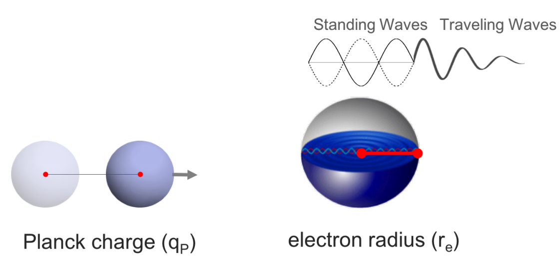

Fig. 1.2 – Electron wave amplitude and wave transition radius

The values for both of these are measured as a distance, in units of meters. Eqs. 1.1 to 1.5 are the **only five constants** required. Everything else in this paper will be derived from these five constants.

$$q_P = 1.87555 \cdot 10^{-18} \, (m) \qquad \textbf{(1.4)}$$

$$r_e = 2.81794 \cdot 10^{-15} \, (m) \qquad \textbf{(1.5)}$$

Unit Relationships

In the simplified kg/m/s unit system, there are only three units required for all equations. But there are also fundamental constants that relate each of these units. Distance and time can be linked together as meters per second (m/s), otherwise known as speed. And mass and distance can be linked together as kilograms per meter (kg/m), otherwise known as a linear density.

The fundamental speed of the universe is the speed of light (c), which is the relationship of the Planck length to Planck time as shown in Eq. 1.6.

$$c = \frac{l_P}{t_P} = 2.99792 \cdot 10^8 \, (m) \tag{1.6}$$

The fundamental linear density is the magnetic constant (μ_0), shown in Eq. 1.7 as the relationship between Planck mass and Planck length. For the magnetic constant to be recognized correctly in kilograms per meter units, the unit of charge (Coulombs) is replaced with the unit of distance (meters). Also, note the geometric ratio (α_μ) in Eq. 1.7. It is explained in Eq. 2.1.1 in the next section on the geometry of spacetime.

$$\mu_0 = \frac{m_P}{l_P}\alpha_\mu = \frac{m_P}{l_P}\left(\frac{4\pi l_P^2}{q_P^2}\right) = \frac{4\pi m_P l_P}{q_P^2} = 1.25664 \cdot 10^{-6}\left(\frac{kg}{m}\right) \tag{1.7}$$

2. The Geometry of Spacetime

Nature often repeats itself and nature often finds a way to optimize. The proposed structure of the spacetime lattice includes repeating cells, called a unit cell in the study of molecules. Nature is likely repeating itself from the smallest of structures as it builds. A body-centered cubic (bcc) structure of a unit cell with a separation length (a) is described in Fig. 2.1. In the bcc structure, a granule exists in the center of the unit cell and eight granules are located at the vertices of the cube. Each of these granules has a radius of Planck length, and a diameter of twice this length (2 * l_P). Euler's number (e – 2.71828) is the base of the natural logarithm, and thus often found in nature. The total separation length of the unit cell is a granule diameter times Euler's number (2 * l_P * e). It is nature's way of optimization and it is found in the separation length of granules in the unit cell.

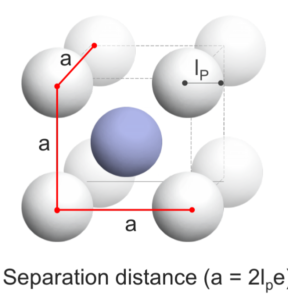

Fig. 2.1 – Unit cell granule separation length (e is Euler's number)

In Fig. 2.1, the center granule is color coded in blue. It is meant to signify that this granule is at the center of vibration, such as Fig. 2.2. If it vibrates and the total displacement is a distance of Planck charge, it collides with and has a cascading effect on other granules. Collectively, they form a spherical wavefront with a longitudinal wavelength (λ) that is also based on Euler's number (2 * q_P * e^2), but it is now the square of Euler's number as it will be calculated based on the surface area of a sphere.

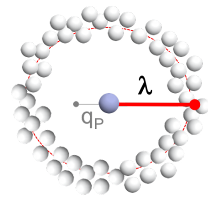

Fig. 2.2 – Granule harmonic displacement and wavelength

The relationships of separation distance of granules in a unit cell (a) and the separation of granules when traveling as longitudinal waves (λ) are expressed in Eqs. 2.1 and 2.2. They will be proven later in the derivation of Avogadro's constant and the fundamental frequency respectively.

$$a = 2l_P e \qquad \textbf{(2.1)}$$

$$\lambda = 2q_P e^2 \qquad \textbf{(2.2)}$$

2.1 Sphere-to-Pyramid (Volume Ratio)

The volume relationship of a sphere compared to a pyramid is one of two key ratios of geometric shapes. As granules spread spherically, the volume that it occupies at any radius (l) is described in Fig. 2.1.1 as V_s. This is the geometry of a particle, such as the electron. However, the energy from the particle when measured at a distance as a force on another particle is the result of granules colliding and spreading from the source of original vibration. This forms a pyramid of height (l) and base with equal length and width (b), for a volume of V_p. This shape is often used when describing the inverse square law and how the effects of a force declines with the square of distance.

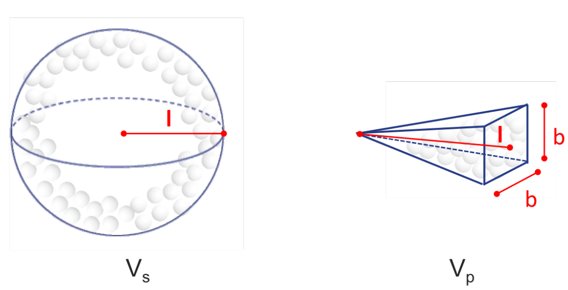

Fig. 2.1.1 – Volumes of sphere (V_s) and pyramid (V_p)

The geometric ratio of the sphere to pyramid (V_s/V_p) was already used in the previous section to derive the magnetic constant. At the smallest level, it describes a sphere with radius Planck length. With a vibration and displacement of Planck charge, it is now stretched in the volume of a pyramid with a height of Planck length and base width and length of Planck charge. This is expressed in Eq. 2.1.1.

$$\alpha_{\mu} = \frac{V_s}{V_p} = \frac{\frac{4}{3}\pi l_P^3}{\frac{1}{3} l_P q_P^2} = \frac{4\pi l_P^2}{q_P^2} \qquad \textbf{(2.1.1)}$$

2.2 Rectangle-to-Sphere/Cone (Surface Area Ratio)

The second of two key geometric relationships is the ratio of the surface area of a rectangle to the surface area of a combination of sphere and cone. The geometry remains the same but the amplitude displacements will be the difference and cause of three forces: strong, magnetic and gravitational. In physics equations, the relationship of these forces relative to the electric force is described by coupling constants. For example, the fine structure constant (α) expresses the dimensionless ratio between the electric force and strong force [6]. These coupling constants can be derived mathematically from this single geometric relationship, which not only explains the dimensionless units of coupling constants, but also the introduction of pi (π) into equations.

The surface area of a rectangle represents the penetration of a shape such as the unit cell by a granule in (1) in Fig. 2.2.1. In a bcc unit cell, the granule colored blue is illustrated moving in (2), hitting maximum displacement and reversing in (3) and finally returning to equilibrium in (4). This motion has a direct effect on the granules at the vertices of the unit cell which spread spherically, having a cascading effect on other unit cells. But at the same time, the motion of the granule in one direction also has an effect on the center granule of the next unit cell. This motion also cascades and the geometry can be represented by a cone. The surface areas of the sphere and cone are added together as any granule in touch with any point on these surface areas may cause a change in amplitude.

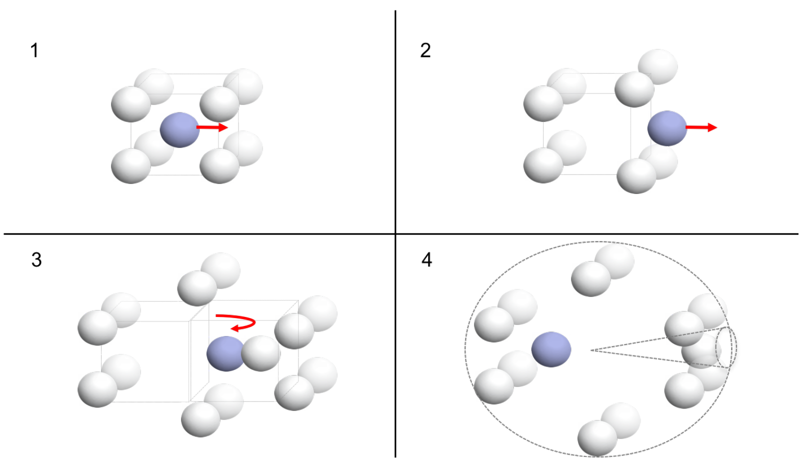

Fig. 2.2.1 – Vibration of center granule

In this harmonic motion, the displacement and return to equilibrium is a π cycle and can be represented by a sine wave with a half wavelength. The ratio of a rectangular surface area (S_r) will be compared to the surface area of a sphere plus cone (S_s). The width and height of the rectangle is x and y. The radius of the cone is d, and the length of both the cone and the radius of the sphere is l. Length (l) is π * d. This was described in detail in *The Relationship of the Fine Structure Constant and Pi* paper due to the difference between the time that it takes for a granule to vibrate and return to equilibrium and the time that it takes for a granule that is traveling in one direction at constant speed. It is also described visually later in Fig. 3.2.1.

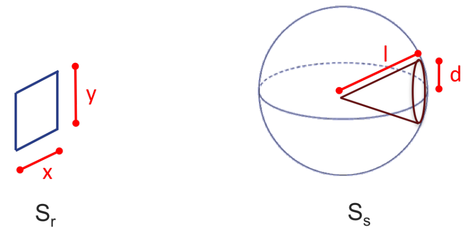

Fig. 2.2.2 – Surface areas of rectangle (S_r) and unit cell of a sphere+cone (S_s)

This is expressed in equation format in Eq. 2.2.1 with the surface area of a rectangle (x * y), the surface area of a sphere (4 * π * l^2) and the surface area of a cone (π * d * l + π * d^2).

$$\frac{(x)\,(y)}{4\pi\,(l)^2 + (\pi d\,(l) + \pi d^2)} \qquad \textbf{(2.2.1)}$$

Strong Force ($x=r_e$; $y=r_e$; $d=r_e$; $l=\pi*r_e$)

The strong force is responsible for binding quarks together to form protons and neutrons or to bind these particles together to form the nucleus of atoms. It can be modeled with the geometry ratio in this section down to a specific unit cell of separation length a, where a single granule affects other granules in its proximity. In this case, using Eq. 2.2.1, all of the variables would be set to the separation length (a), where l is π*a for reasons described above. However, it is also proportional as it expands and cascades outwards and this distance will be set to the electron's classical radius (r_e) to compare it to the magnetic and gravitational forces coming next. Inserting the electron's radius for x, y, l and d into Eq. 2.2.1 yields:

$$\alpha = \frac{r_e^2}{4\pi\,(\pi r_e)^2 + (\pi r_e\,(\pi r_e) + \pi r_e^2)} = \frac{1}{4\pi^3 + \pi^2 + \pi} = 0.00729734 \qquad \textbf{(2.2.2)}$$

This is the numerical value for the fine structure constant, which is the ratio of the electric force to the strong force. All calculations of fundamental physical constants in this paper are shown in the format *equation* = *value* (*units*) and match known CODATA values of the constants [7]. The fine structure constant, however, is dimensionless and thus no units appear in this equation. An explanation of the ratio and how it may produce the strong force is provided in Section 3.4.

Magnetic Force ($x=r_e$; $y=$**r** ; $d=r_e$; $l=\pi*r_e$)

The magnetic force seen in dipole magnets can be modeled mathematically, similar to the strong force and its surface area ratio compared to the electric force, but now with a variable distance (r) to the measured particle that is being influenced by such force. The only difference between Eq. 2.2.3 is the y value of the rectangle which is now replaced with the variable distance (r) instead of the electron's radius (r_e). The portion of the equation with the ratio including π is replaced by the fine structure constant (α) in Eq. 2.2.2 to simplify. As a result of containing a variable, Eq. 2.2.3 cannot be solved by itself without knowing the value of r. In Section 3.4, the geometry of the dipole and how it has an effect on keeping an electron in an atomic orbital is provided.

$$\alpha_{Me} = \frac{r_e(r)}{4\pi(\pi r_e)^2 + (\pi r_e(\pi r_e) + \pi r_e^2)} = \frac{r_e(r)}{r_e^2(4\pi^3 + \pi^2 + \pi)} = \frac{\alpha r}{r_e} \quad \textbf{(2.2.3)}$$

Gravitational Force (x=**l_P** ; y=**l_P** ; d=r_e ; l=π*r_e)

The gravitational force is also modeled with the same ratio of geometric shapes, but with a smaller cross section for the surface area of the rectangle, which is now equal to the cross-section of the radius of a granule – the Planck length. Both x and y are set to Planck length (l_P) in Eq. 2.2.1. The radius of the cone and its length is still based on the electron's radius, similar to the previous two coupling constants. Similar to the magnetic force above, the portion of the equation with the ratio including π is replaced by the fine structure constant (α) in Eq. 2.2.2 to simplify.

$$\alpha_{Ge} = \frac{l_P^2}{4\pi(\pi r_e)^2 + (\pi r_e(\pi r_e) + \pi r_e^2)} = \frac{l_P^2}{r_e^2(4\pi^3 + \pi^2 + \pi)} = \frac{\alpha l_P^2}{r_e^2} = 2.4006 \cdot 10^{-43} \quad \textbf{(2.2.4)}$$

This is the numerical value for the gravitational coupling constant when expressed as a ratio between the force of gravity and the electric force *of two electrons* [8]. An explanation of the ratio and how it may produce the gravitational force is provided in Section 3.4.

3. Spacetime Modeled as a Spring-Mass System

The spacetime lattice of repeating bcc unit cells may be described as a spring-mass system and mathematically modeled with classical mechanics, even though it is not expected that spacetime literally includes *springs*. It is a representation of a unit cell with a center granule of Planck mass, with harmonic motion, affecting and displacing nearby granules in the lattice. Its harmonic motion produces a wave-like effect over time, where the distance from equilibrium over time is a sinusoidal wave, and the maximum displacement becomes the wave amplitude. At the center of the electron, it will be shown that this amplitude is Planck charge (q_P).

The radius of the granule was established in Section 1 as Planck length (l_P). This incredibly small length sets the default value for measuring a distance. Yet, the macroscopic world in which we live sets the measuring stick for the meter to be something recognizable in size to humans (one meter is roughly the height of a human toddler). A distance (r), in the measuring stick established for the meter, can be calculated using the Planck unit system by multiplying the Planck length (l_P) and the cumulative number (j) of such lengths in the distance being measured. For example, a distance of one meter is equivalent to 6.187×10^{34} Planck lengths. This relation can be expressed as $r = j * l_P$ and is illustrated in Fig. 3.1.

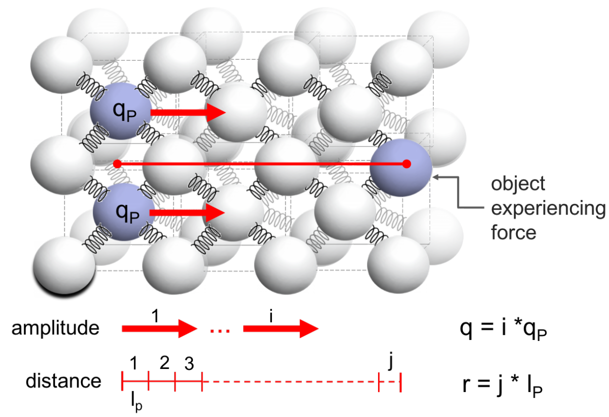

Fig. 3.1 – Spacetime as a spring-mass system

The previous figure also includes the cumulative effect of constructive wave interference on amplitude. Similar to the measuring stick for distance, the macroscopic world in which we live measures the effects of numerous particles, not a single electron. It is the effect of many granules colliding and transferring energy, producing waves and traveling through the spacetime lattice as wavelets according to Huygen's principle [9]. The process of multiple granules in the same wave phase transferring energy can also be represented in the spring-mass system as parallel springs, where the force is additive [10]. This amplitude is measured as the variable for charge (q), where it is a number of particles (i) that have Planck charge amplitude (q_P), related as q = i * q_P, seen in Fig. 3.1 and further illustrated in Fig. 3.2.

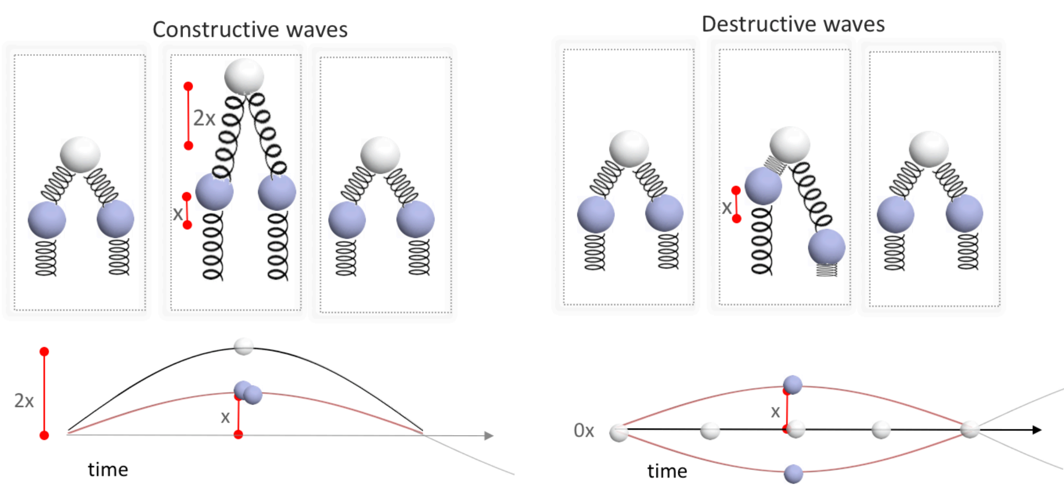

Fig. 3.2 – Constructive and destructive wave interference

The behavior of granules transferring energy will be constructive or destructive, depending on the direction of travel of nearby granules. In the same phase (traveling in same direction), amplitude is constructive as shown in the left of Fig. 3.2, and when in opposite phase (traveling in opposite directions), amplitude is destructive as shown on the right. This is equivalent to a spring system with parallel springs in which the spring constant (k) is additive ($k = k_1 + k_2$).

The cumulative effect of charge (q) and measurement of distance (r) is summarized as:

$$q = i\,(q_P) \qquad \textbf{(3.1)}$$

$$r = j\,(l_P) \qquad \textbf{(3.2)}$$

3.1 The Fundamental Force

The energy (E) of a granule with Planck mass and the force (F) of this energy at a distance of Planck length is:

$$E = m_P c^2 \tag{3.1.1}$$

$$F = \frac{m_P c^2}{l_P} \tag{3.1.2}$$

Eq. 3.1.2 contains a ratio between the Planck mass and Planck length, which can be substituted with the magnetic constant (μ_0) from Eq. 1.7 when the volume ratio of the sphere to pyramid (α_u) is used. This makes Eqs. 3.1.2 and 3.1.3 identical in value, but now Eq. 3.1.3 is expressed in terms of a linear density so that it can be used to apply to multiple particles.

$$F = \mu_0 c^2 \frac{1}{\alpha_\mu} = \mu_0 c^2 \left(\frac{q_P^2}{4\pi l_P^2} \right) \tag{3.1.3}$$

Eq. 3.1.3 is the fundamental force between two granules in a spring-mass system. Because forces will be measured as a result of many particles with charge (q), across a distance (r) that is an accumulation of Planck lengths, these variables replace the Planck charge and Planck length variables according to Eqs. 3.1 and 3.2.

$$F = \mu_0 c^2 \left(\frac{q^2}{4\pi r^2} \right) = \frac{\mu_0 c^2}{4\pi} \left(\frac{q^2}{r^2} \right) \tag{3.1.4}$$

After the variables are separated on the right in parentheses, the constants in the equation are recognized as the Coulomb constant (k_c). 4π appears in the denominator naturally as a result of the geometry ratio between the sphere and pyramid.

$$k_e = \frac{\mu_0 c^2}{4\pi} = 8.98755 \cdot 10^9 \left(\frac{kg\,(m)}{s^2} \right) \tag{3.1.5}$$

3.2 The Fundamental Frequency

For space and time to be intertwined as spacetime, the definition of time must be inherent in the geometry of the spacetime lattice itself. It is the harmonic motion of its components. In Fig. 3.2.1, the vibration of a granule is illustrated in blue in the left of the diagram as it completes one wavelength. On the right of the figure, it is compared to a granule traveling at a constant speed that travels a distance (l). This is the cone radius (d) and slant length (l) used earlier in Section 2.2.

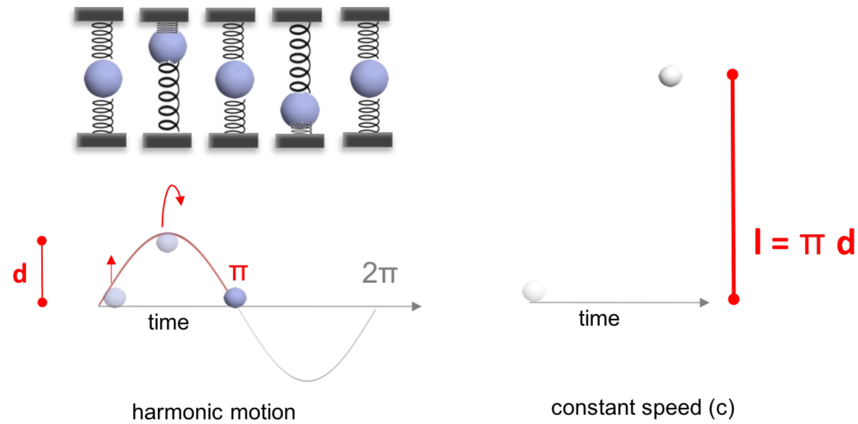

Fig. 3.2.1 – Harmonic motion of granule vibration creating a fundamental frequency

It becomes a fundamental frequency and a fundamental wavelength. The displacement of granules is in the same direction as motion, so it becomes a longitudinal wave. Photons, which are transverse waves where vibration is perpendicular to wave propagation, will be addressed later in Section 4.

The fundamental frequency can be mathematically represented like the frequency in a spring-mass system. Eq. 3.2.1 represents the equation for the frequency of a spring with spring constant (k) and mass (m) [11].

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \quad \textbf{(3.2.1)}$$

A spring constant (k) can be determined by the force (F) divided by displacement (x). In the case of a unit cell, the fundamental force is the Coulomb constant (from Eq. 3.1.5) divided by the granule separation length (a – from Eq. 2.1). *Note that the spring constant (k) and Coulomb constant (k_e) have different units, even though both use the letter k.*

$$k = \frac{F}{x} = \frac{k_e}{a} \quad \textbf{(3.2.2)}$$

In a unit cell, the mass in the spring-mass system is a granule of Planck mass (m_P). This mass is substituted into Eq. 3.2.1. The spring constant (k) from Eq. 3.2.2 is also substituted. The fundamental longitudinal frequency (f_l) and the fundamental longitudinal wavelength (λ_l) are calculated as:

$$f_l = \frac{1}{2\pi}\sqrt{\frac{k_e}{(a)\, m_P}} = 1.09107 \cdot 10^{25}\left(\frac{1}{s}\right) \quad \textbf{(3.2.3)}$$

$$\lambda_l = \frac{c}{f_l} = 2.7477 \cdot 10^{-17}\,(m) \quad \textbf{(3.2.4)}$$

The wavelength value matches the value derived a second way from Eq. 2.2 using Euler's number at 2.7 x 10^{-17} m. This value also sets a lower limit of the possible wavelengths of photons, as the transverse wave would not be able to exceed this longitudinal wavelength.

3.3 Energy of the Spring-Mass System

In a spring-mass system, energy is a function of displacement (x). In the context of a granule in a spacetime unit cell, if the displacement is zero then there is no energy (despite having a mass of Planck mass). The energy (U) of a spring-mass system with spring constant (k) and displacement (x) is illustrated in the next figure and is described in Eq. 3.3.1.

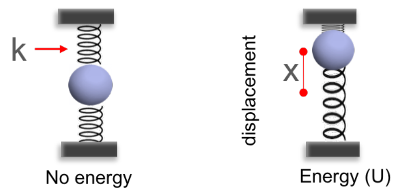

Fig. 3.3.1 – Energy of a spring-mass system for one-way displacement (x)

$$U = \frac{1}{2}kx^2 \tag{3.3.1}$$

The energy equations that follow will model the total energy (E) of a granule being displaced and returning to equilibrium. Thus, Eq. 3.3.1 is used twice as it completes an oscillation.

$$E = \frac{1}{2}kx^2 + \frac{1}{2}kx^2 \tag{3.3.2}$$

As found in Eq. 3.2.2, the spring constant (k) is the Coulomb constant (k_e) divided by the distance at which the force is applied. Now, the distance from the center of an electron will be set to a variable (r). The Coulomb constant is replaced in terms of the magnetic constant (from Eq. 3.1.5) to complete Eq. 3.3.3. In Eq. 3.3.4, the displacement at the center of the electron is the Planck charge.

$$k = \frac{\mu_0 c^2}{4\pi}\left(\frac{1}{r}\right) \tag{3.3.3}$$

$$x = q_P \tag{3.3.4}$$

Substituting Eqs. 3.3.3 and 3.3.4 into Eq. 3.3.2 yields the following. It is labeled a strong energy (E_s) for one-dimensional energy displaced a distance of Planck charge.

$$E_s = \frac{\mu_0 c^2}{4\pi}\left(\frac{q_P^2}{r}\right) \tag{3.3.5}$$

From the description of the motion of a granule in a unit cell (Fig 2.2.1), if it is able to transfer its energy to surrounding granules, it will go through a transformation to spread energy in three-dimensions. It is labeled longitudinal energy (E_l) for spherical, three-dimensional longitudinal waves. The geometric ratio that is the fine structure constant (α) from Eq. 2.2.2 is applied to the equation.

$$E_l = E_s\alpha = \frac{\mu_0 c^2}{4\pi}\left(\frac{q_P^2}{r}\right)\alpha \tag{3.3.6}$$

The fine structure constant is a ratio of geometric shapes and is derived in full in *The Relationship of the Fine Structure Constant and Pi* from a ratio of the square of amplitudes of the one-dimensional wave and three-dimensional wave propagation. In other words, the elementary charge (e_e) is the displacement amplitude at the surface of a sphere propagating in three-dimensions when the displacement amplitude of the center granule is Planck charge (q_P). The following was found as the relationship in the paper and is the derivation of the elementary charge:

$$e_e^2 = q_P^2 \alpha \tag{3.3.7}$$

$$e_e = \sqrt{q_P^2 \alpha} = 1.602 \cdot 10^{-19} \ (m) \tag{3.3.8}$$

Eq. 3.3.7 can be substituted into Eq. 3.3.6 to represent longitudinal energy in terms of the elementary charge.

$$E_l = \frac{\mu_0 c^2}{4\pi} \left(\frac{e_e^2}{r} \right) \tag{3.3.9}$$

All of the fundamental physical constants derived in Section 4 are done with a single electron particle, with either one-dimensional Planck charge amplitude or three-dimensional elementary charge amplitude. However, for completeness of an equation that represents multiple particles that are eventually used to calculate forces, the delta symbol (Δ) will be used to signify constructive or destructive wave interference (see Figs. 3.1 and 3.2). The calculation of wave interference is dependent on the number of particles in each group separated by distance, as seen in equations using both charge (q) and mass (m) as variables. For single particle interaction, $\Delta=1$ and is excluded from equations.

$$E_l = \frac{\mu_0 c^2}{4\pi} \left(\frac{\Delta e_e^2}{r} \right) \tag{3.3.10}$$

3.4 Forces and the Geometry of Spacetime

The ratio of the surface areas of a rectangle and a combination of a sphere/cone is further explained here and how it relates to the forces that cause the motion of particles like the electron. A force (F) can be expressed as energy (E) over a distance (r):

$$F = \frac{E}{r} \tag{3.4.1}$$

Electric Force

The electric force is the fundamental force. Earlier, it was established that the Coulomb constant represents the fundamental force between granules in a unit cell – it is the constant of the electric force. If the displacement at the center of the electron is Planck charge, and this energy is transferred to a unit cell to spread spherically, then the displacement of granules at the vertices of the unit cell will be a length of the elementary charge (e_e). As they travel outwards, colliding with a greater number of granules, it loses energy proportional to distance.

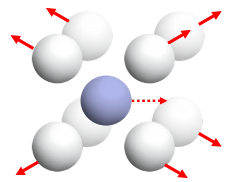

Fig. 3.4.1 – Electric force amplitude ratio

The electric force is the longitudinal energy from Eq. 3.3.10 substituted into Eq. 3.4.1. It is represented here in terms of a number of elementary charges (e_e) that constructively interfere (Δ). It is otherwise also known as Coulomb's law.

$$F_e = \frac{E_l}{r} = \frac{\mu_0 c^2}{4\pi}\left(\frac{\Delta e_e^2}{r^2}\right) \tag{3.4.2}$$

Strong Force

The strong force may be explained by the transfer of energy from granules in the vertices of a unit cell to the center granule, causing one-dimensional motion. It is calculated as the amplitude ratio between a granule that penetrates the unit cell surface area and the effect of the granules in the vertices or in the direction of motion in the next unit cell (the sphere + cone geometry). For example, if the granules at the vertices of a unit cell were unable to move and spread spherically, the energy of the center granule would be greater as it would not be able to transfer its energy. This changes the wave behavior from spherical (three-dimensional) to linear (one-dimensional). Resonance could be one potential cause, where incoming waves of granules are perfectly timed to coincide at the vertices of the unit cell with outgoing, causing the only movement to occur in one direction.

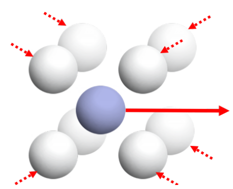

Fig. 3.4.2 – Strong force amplitude ratio

The electric force is the fundamental force. Therefore, a change in geometry for the strong force is applied to the electric force as it transitions to one-dimensional. The ratio of surface area geometries (the fine structure constant) is applied in Eq 3.4.3. Then, Eq. 3.4.2 is substituted for F_e, and finally the elementary charge is converted to Planck charge according to the relationship in Eq. 3.3.7.

$$F_s = F_e \frac{1}{\alpha} \tag{3.4.3}$$

$$F_s = \frac{\mu_0 c^2}{4\pi}\left(\frac{e_e^2}{r^2}\right)\frac{1}{\alpha} = \frac{\mu_0 c^2}{4\pi}\left(\frac{q_P^2}{r^2}\right) \tag{3.4.4}$$

The strong force is already known to be the ratio of the electric force as described in Eq. 3.4.3, so this is not proof itself. The description of the force as one-dimensional fits the description of quarks in a nucleon as it is the strong attraction between two quarks. The distance (r) at which the force acts will be further explained in the magnetic force.

Gravitational Force

The gravitational force is geometrically similar to the strong force, but at a significantly smaller scale. The derivation of the gravitational coupling constant in Section 2.2 describes the center granule being displaced a distance of Planck length (l_P). One possible explanation for this small displacement is a result of some granules at the vertices of the unit cell colliding with the center granule, causing a displacement before the other granules reach it. This is illustrated in the next figure as the granules to the left of the center granule (blue) reach it and cause motion from left-to-right, before colliding with the granules to the right which will eventually reverse the motion.

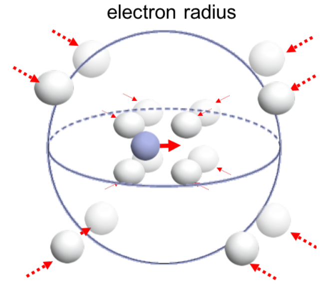

Fig. 3.4.3 – Gravitational force amplitude ratio

The geometry ratio for gravitation (from Eq. 2.2.4) is applied to the electric force in Eq. 3.4.5. After substitution, the gravitational force equation when expressed in terms of electrical properties is found in Eq. 3.4.6. However, most gravitational equations rely on mass, not charge, as variables. The conversion from charge to mass and the derivation of the gravitational constant (G) as proof of this equation will be shown in Section 4.8.

$$F_g = F_e \alpha_{Ge} \quad \textbf{(3.4.5)}$$

$$F_g = \frac{\mu_0 c^2}{4\pi}\left(\frac{\Delta e_e^2}{r^2}\right)\frac{l_P^2 \alpha}{r_e^2} \quad \textbf{(3.4.6)}$$

Magnetic Force

The magnetic force of dipole magnets, which decreases in strength at the cube of distance from the source, is also similar to the geometry ratio of the strong force. In an atom, a proton may be paired with an electron. A proton is a known composite particle, containing at least three quarks (in some cases, five quarks have been found) [12]. The strong force illustration from Fig 3.4.2 is now applied to two quarks in the proton in the figure below (on left) along the axis of an electron (on right).

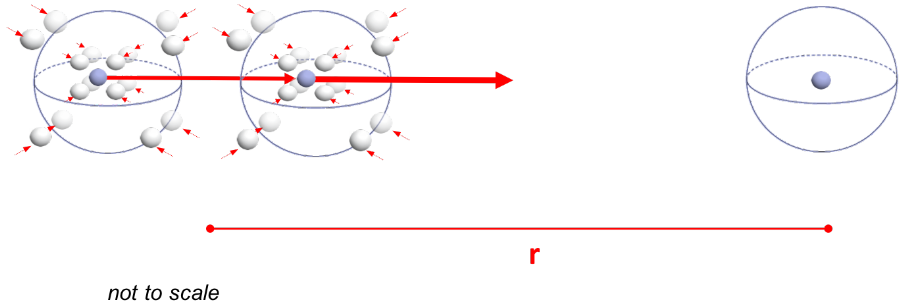

Fig. 3.4.4 – Magnetic force amplitude ratio

In the far left of Fig 3.4.4, a quark undergoes the geometric transformation resulting in the strong force and binding with a second quark. The second quark also undergoes the same geometric transformation, further increasing the wave amplitude along the one-dimensional axis. It is significantly increased, but it will decrease at the cube of distance at the point where the force is measured (r).

The force is labeled as F_o because of the effect it has on an electron in the orbit of an atom, which will be further described in Section 4 and proven for the calculation of electron orbital distances and energies. The geometry ratio for the magnetic force of the electron (α_{Me}) is applied to the strong force (F_s) already derived in Eq. 3.4.4, because it is going through the same transformation a second time, but now with a variable distance r that the force will be calculated. This is expressed in Eq. 3.4.7. Eqs. 2.2.3 and 3.4.4 are then substituted and simplified to become Eq. 3.4.8. The Planck charge is also substituted for the elementary charge by using Eq. 3.3.7.

$$F_o = F_s \frac{1}{\alpha_{Me}} \tag{3.4.7}$$

$$F_o = \frac{\mu_0 c^2}{4\pi}\left(\frac{\Delta q_P^2}{r^2}\right)\left(\frac{r_e}{\alpha r}\right) = \frac{\mu_0 c^2 r_e}{4\pi\alpha^2}\left(\frac{\Delta e_e^2}{r^3}\right) \tag{3.4.8}$$

4. Explaining the Universe's Fundamental Constants

The derivation of the preceding energy and force equations are ultimately traced back to only five constants in Section 1, and the forces are traced back to one surface area ratio with different surface lengths and widths. The magnetic constant, the fine structure constant, the Coulomb constant and the elementary charge are fundamental physical constants that are naturally derived in the process of explaining the conservation of energy as it changes in geometry and wave form.

Ten additional fundamental physical constants from physics equations may also be derived from the base Planck unit system, explaining why they appear in equations and offering further proof of the geometry of spacetime. For example, Eq. 3.4.6 describes the gravitational force, which is well documented and known to be proportional to the gravitational constant (G) when mass and distance are used as variables. By deriving G, it is assumed that it is proof of the gravitational force equation. Or by deriving the Planck constant (h), it is assumed that it is proof of the energy equation for photons.

This section includes derivations based on single electron interactions. As a result, no constructive or destructive wave interference is used or needed for the derivation of fundamental physical constants (Δ=1). However, for calculations of energies and forces of multiple particles, constructive interference should be assumed (Δ<>1). This is known to be the addition or subtraction of particles of charge (q) or mass (m).

All figures in this section are not to scale as it ranges from Planck length to the Bohr radius which is many orders of magnitude larger.

4.1 Electron Energy & Mass

From the description of the energy of the spacetime lattice in Section 3 (Fig. 3.1), energy continually spreads from the center of the particle spherically, decreasing in granule amplitude (displacement) proportional to the distance from the center. Within a defined radius, this energy is measured as particle energy (or mass without c^2). Beyond this radius, energy continues but it is no longer considered to be within the confines of a particle. Its energy affects other particles, which is seen as the electric force (energy over distance).

It is the wave form that defines a particle and its boundary. When incoming waves of the same frequency meet outgoing waves of the same frequency, a phenomenon known as standing waves may occur. The outgoing waves created by each and every particle is traveling the spacetime lattice until reaching other particles, becoming inwaves for other particles. When this occurs, a standing wave forms. And a standing wave contains energy, but there is no net propagation of energy [13]. In other words, it is stored energy.

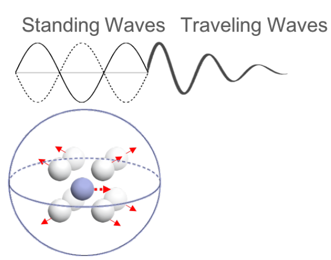

Fig. 4.1.1 – Electron energy and mass

The transition where standing waves become traveling waves and energy is no longer stored is at the electron's classical radius (r_e). The same longitudinal energy equation used to derive the electric force (Eq. 3.3.9) is used to derive the electron's energy (E_e) and mass (m_e) in electrical constants, where the distance (r) is the electron's radius. Mass is Eq. 4.1.1 without wave speed c^2.

$$E_e = \frac{\mu_0 c^2}{4\pi}\left(\frac{e_e^2}{r_e}\right) = 8.1871\cdot 10^{-14}\left(\frac{kg\,(m^2)}{s^2}\right) \quad \textbf{(4.1.1)}$$

$$m_e = \frac{\mu_0}{4\pi}\left(\frac{e_e^2}{r_e}\right) = 9.1094\cdot 10^{-31}\,(kg) \quad \textbf{(4.1.2)}$$

4.2 Bohr Radius

The energy of an electron continues beyond its radius, as derived in the electric force. When the force experiences constructive wave interference between an electron and a particle of the same wave phase (e.g. another electron), the particle motion is away from each other. When it experiences destructive wave interference with a particle of opposite wave phase (e.g. a positron) the particle motion is towards each other. In Fig. 4.2.1, an electron is attracted via the electric force (F_e) to a positively charged particle in the proton.

As described in Section 3.4, a magnetic force occurs in an alignment of two or more quarks in the proton. It can be shown that this force keeps the electron in orbit, forcing it out of the proton to balance the attractive force that pulls it in. The position of the electron is where opposing forces are equal. This application of the magnetic force will be labeled an orbital force (F_o).

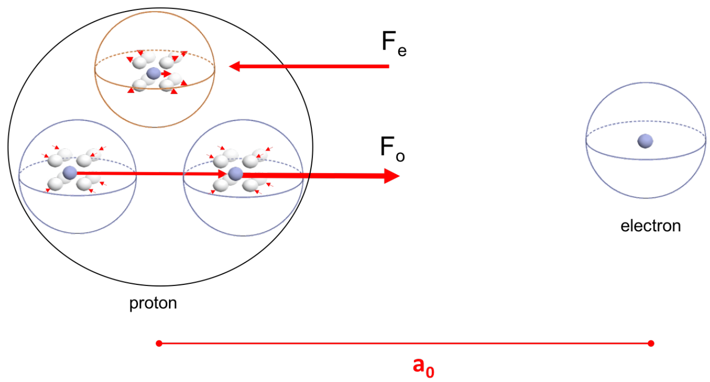

Fig. 4.2.1 – Single proton and electron (Bohr radius)

The electric forces and orbital forces are set to equal for the position where the forces on an electron is zero and it will be in a stable *orbit*. Eqs. 3.3.9 and 3.4.9 are substituted into Eq. 4.2.1 to solve for the forces.

$$F_e = F_o \quad \textbf{(4.2.1)}$$

$$\frac{\mu_0 c^2}{4\pi}\left(\frac{e_e^2}{r^2}\right) = \frac{\mu_0 c^2 r_e}{4\pi\alpha^2}\left(\frac{e_e^2}{r^3}\right) \quad \textbf{(4.2.2)}$$

After solving for r in Eq. 4.2.2, the distance is found to be the Bohr radius (a_0) – which is the most probable location of an electron in an orbit around a single proton (hydrogen).

$$r = \frac{r_e}{\alpha^2} \quad \textbf{(4.2.3)}$$

$$a_0 = \frac{r_e}{\alpha^2} = 5.2918 \cdot 10^{-11}\,(m) \quad \textbf{(4.2.4)}$$

4.3 Rydberg Unit of Energy

The energy between a single electron and proton can be solved now, knowing the Bohr radius as the distance between the two. This energy is known as the Rydberg unit of energy (E_{Ry}). The energy equation from Eq. 3.3.9 is used once again – the same equation used to calculate the electron's energy and the electric force.

In Fig. 4.2.1 above, the one-dimensional orbital force (F_o) is on an axis between the proton and electron. This force travels in both directions from the proton, eventually requiring an electron on the opposite side in an atom when more protons are added to balance the electric force. As a result, half of the energy is on the side between the proton and electron. A factor of ½ is applied to the longitudinal energy, as shown in Eq. 4.3.1. Then, Eq. 3.3.9 is substituted into Eq. 4.3.1 and the Bohr radius (a_0) is used as the distance r. It resolves correctly to be the Rydberg unit of energy.

$$E_{Ry} = \frac{1}{2} E_l \qquad \textbf{(4.3.1)}$$

$$E_{Ry} = \frac{1}{2} \frac{\mu_0 c^2}{4\pi} \left(\frac{e_e^2}{a_0} \right) = 2.1799 \cdot 10^{-18} \left(\frac{kg\,(m^2)}{s^2} \right) \qquad \textbf{(4.3.2)}$$

4.4 Avogadro's Constant

The energy between a single electron and proton is constant, as found in the Rydberg unit of energy. The mass contained in the unit cells that transfer this energy between the electron and proton is also constant. And the total number of unit cells will be shown to be equal to Avogadro's constant (N_A).

In 1834, Michael Faraday found that the mass of a substance altered proportional to the charge in electrolysis, in what became known as Faraday's law of electrolysis – the Faraday constant is proportional to the elementary charge (e_e) and Avogadro's constant (N_A). It demonstrates that Avogadro's constant represents a number of something responsible for charge, which are unit cells between a proton and electron where the initial displacement is the elementary charge. Furthermore, since the proton and electron form the fundamental atom (hydrogen), and since all atoms and molecules are formed from a combination of protons and electrons, it would follow that Avogadro's constant would appear in other atoms with a greater number of protons, and also from molecules that are formed from such atoms.

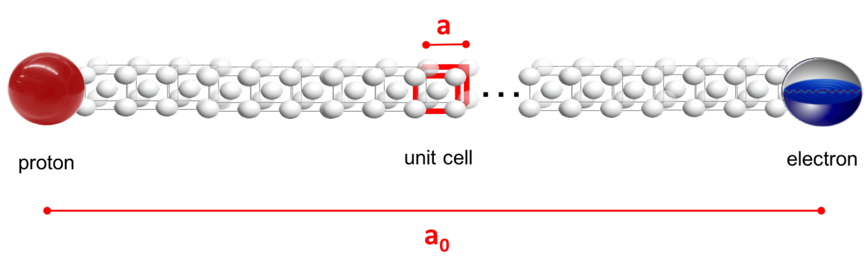

Fig. 4.4.1 – The number of unit cells between a single proton and electron – Avogadro's constant

The calculation of Avogadro's constant is found in Eq. 4.4.1. It is the probable distance between a single proton and electron (the Bohr radius, a_0, from Eq. 4.2.4), divided by the length of a spacetime unit cell (a, from Eq. 2.1). It resolves to be the total number of unit cells between the proton and electron – Avogadro's constant.

$$N_A = \frac{a_0}{a} = 6.022 \cdot 10^{23} \tag{4.4.1}$$

4.5 Planck Constant

The Planck constant (h) is used in equations to describe photon energies, where energy is proportional to frequency (E=hf). A photon is a transverse wave, which is when the vibrating element moves perpendicular to wave propagation (unlike a longitudinal wave that is in the same direction of wave propagation).

Referring back to Fig. 4.2.1, the electron's position in a stable orbit is when the attractive electric force (F_e) and the repelling orbital force (F_o) are the same. When the electron is closer or further than this range, they are unequal, causing motion of the electron. While in motion, the granules at the center of the electron likely avoid the one-dimensional F_o force, since it repels along a defined axis. Yet, they should continue to be attracted to the F_e force, which is spherical, but the attraction is strongest when minimizing the distance between the particles. This causes a vibration of the granules within the center of the electron in the direction perpendicular to the line of the F_o force from the proton. Fig. 4.5.1 describes this vibration (illustrated as up-down in the figure), creating a transverse wave. It now has a two-dimensional vibration while the electron is in motion as it continues to respond to incoming waves, oscillating a distance of Planck charge (q_P).

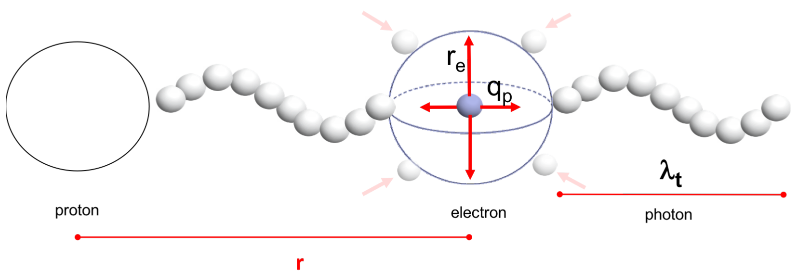

Fig. 4.5.1 – Generation of a photon as a transverse wave

The equation that models the photon's transverse energy (E_t) once again starts with Eq. 3.3.9. However, half of the energy is considered for one side of the particle, similar to what is found with the equation for the Rydberg unit of energy. Also, since the energy of the photon is transferred along a single axis, the elementary charge is replaced with the Planck charge according to the relation with the fine structure constant in Eq. 3.3.7. The transverse wave represents a conservation of energy from the longitudinal wave form as two photons from each side of a particle represented in Eq. 4.5.1 would be identical to the spherical, longitudinal wave energy from Eq. 3.3.9.

$$E_t = \frac{1}{2}\frac{\mu_0 c^2}{4\pi}\left(\frac{q_P^2 \alpha}{r}\right) \tag{4.5.1}$$

Eq. 4.5.1 can be rearranged to separate constants to the left of the equation. The Planck constant (h) is now on the left (accurately calculated in Eq. 4.5.3) and the variables required for frequency are isolated in parentheses on the right of Eq. 4.5.2. The latter will be proven to be frequency in the next section.

$$E_t = \frac{\mu_0 c q_P^2}{2}\left(\frac{\alpha c}{4\pi r}\right) \tag{4.5.2}$$

$$h = \frac{\mu_0 c q_P^2}{2} = 6.6261 \cdot 10^{-34} \left(\frac{kg\,(m^2)}{s} \right) \quad \textbf{(4.5.3)}$$

4.6 Rydberg Constant

Eq. 4.5.2 expresses the Planck relation (E=hf) in terms all derived from the original four Planck units and the electron radius from Section 1. While the constants that constitute the Planck proportionality constant are on the left, the remaining variables and constants within parentheses are frequency. For a single proton and electron, the distance (r) is the Bohr radius (a_0). Inserting this distance into Eq. 4.5.2 yields the transverse wave frequency for a photon at ground state hydrogen.

$$f_0 = \frac{\alpha c}{4\pi a_0} = 3.29 \cdot 10^{15} \left(\frac{1}{s} \right) \quad \textbf{(4.6.1)}$$

This frequency is more commonly expressed as the Rydberg constant (R_∞), which is found by removing wave speed (c) from Eq. 4.6.1 such that it becomes an inverse of wavelength:

$$R_\infty = \frac{\alpha}{4\pi a_0} = 1.097 \cdot 10^{7} \left(\frac{1}{m} \right) \quad \textbf{(4.6.2)}$$

This section derives fundamental physical constants with only single particle interaction (one electron or one proton), ignoring the constructive wave interference expressed in the energy equation from Eq. 3.3.10. Calculating the frequency of atoms with multiple protons does indeed require constructive wave interference (Δ), which results in two variables in the frequency equation. The complete equation for frequency is found below, and has been validated by calculating energies and frequencies of photons from hydrogen to calcium in a separate paper [14].

$$f = \frac{\Delta \alpha c}{4\pi r} \quad \textbf{(4.6.3)}$$

4.7 Compton Wavelength

The Compton wavelength (λ_C) occurs when photon energy is equal to a particle's rest energy, found in annihilation when an electron and positron annihilate. Eq. 4.6.3 can be used to find this frequency and wavelength. It describes the interaction between single particles (Δ=1). The only remaining variable is the distance at which the particles rest and are stable (r).

From the description of the electron in Section 4.1, standing waves occur within the electron's radius (r_e). From the description of destructive waves in Fig. 3.2, it is assumed that the position halfway between the electron's standing wave radius is the position in which the net amplitude of all granules within the particles is zero. In other words, it is completely destructive at ½ r_e, providing a position for stability of the particles where no longitudinal waves emerge because of their destructive properties. This distance is substituted into Eq. 4.6.3 as shown below to resolve for frequency in Eq. 4.7.1.

Then, the Compton wavelength is solved by using the relationship of frequency and wavelength by taking the inverse and removing wave speed (c). This results in the calculation of the Compton wavelength in Eq. 4.7.2.

$$f_C = \frac{\alpha c}{4\pi \frac{r_e}{2}} = \frac{\alpha c}{2\pi r_e} \qquad \textbf{(4.7.1)}$$

$$\lambda_C = \frac{c}{f_C} = \frac{2\pi r_e}{\alpha} = 2.426 \cdot 10^{-12} \, (m) \qquad \textbf{(4.7.2)}$$

4.8 Gravitational Constant

The gravitational constant (G) is used in the calculation of gravitational forces when the masses of two objects are used as variables. Mass is a collection of a number of particles, including the electron, all of which experience gravity. Thus, at the lowest level, the gravitational constant should appear in single particle interaction even if other forces dominate at this level (the electric force is significantly stronger for two electrons than gravity, repelling them instead of attracting them).

From the explanation of the geometry of gravity in Fig. 3.4.3, a single electron particle is now expanded to illustrate two particles and a shading effect between the particles. In the figure, each electron has incoming wave amplitude at the surface of the sphere that is greater than the outgoing wave amplitude at the surface of the sphere as a result of transferring some energy to motion at the electron's core (center granule is displaced a Planck length).

Ignoring other forces (i.e. the electric force), it would cause an attraction of the particles due to a net force as a result of unequal energy on the opposite sides of the particles due to a shading effect that occurs between the particles.

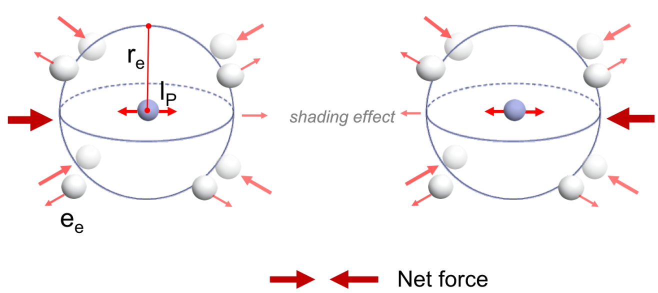

Fig. 4.8.1 – Two particles and a net force forcing particles together as a result of an energy shading effect

The equation to model two electrons begins with the gravitational force equation from Eq. 3.4.6, but with the interaction of single particles (Δ=1).

$$F_g = \frac{\mu_0 c^2}{4\pi} \left(\frac{e_e^2}{r^2} \right) \frac{l_P^2 \alpha}{r_e^2} \qquad \textbf{(4.8.1)}$$

Mass and charge are related as described in Section 4.1. Total mass will eventually be described in equations as a summation of the constructive wave interference of many particles. However, for single particles, the mass of one electron in terms of electrical constants comes from Eq. 4.1.2 and is shown again in Eq. 4.8.2 below. Then, one elementary charge is isolated in Eq. 4.8.3.

$$m_e = \frac{\mu_0}{4\pi}\left(\frac{e_e^2}{r_e}\right) \tag{4.8.2}$$

$$e_e = \frac{m_e 4\pi r_e}{\mu_0 e_e} \tag{4.8.3}$$

Substitute Eq. 4.8.3 into 4.8.1 and simplify.

$$F_g = \frac{\mu_0 c^2}{4\pi}\left(\frac{\left(\frac{m_e 4\pi r_e}{\mu_0 e_e}\right)^2}{r^2}\right)\frac{l_P^2 \alpha}{r_e^2} \tag{4.8.4}$$

$$F_g = \frac{4\pi\alpha c^2 l_P^2}{\mu_0 e_e^2}\left(\frac{m_e^2}{r^2}\right) \tag{4.8.5}$$

The elementary charge in the denominator and the fine structure constant in the numerator can be replaced to convert back to Planck charge, per the relationship in Eq. 3.3.7.

$$F_g = \frac{4\pi c^2 l_P^2}{\mu_0 q_P^2}\left(\frac{m_e^2}{r^2}\right) \tag{4.8.6}$$

$$G = \frac{4\pi c^2 l_P^2}{\mu_0 q_P^2} = 6.674\cdot 10^{-11}\left(\frac{m^3}{kg\,(s^2)}\right) \tag{4.8.7}$$

The constants on the left of Eq. 4.8.6 are the gravitational constant (G), as calculated correctly in both value and units in Eq. 4.8.7. It demonstrates that gravity occurs at a single particle, and its force will be proportional to mass due to constructive wave interference, as mass is the additive interference of multiple particles.

4.9 Bohr Magneton

The Bohr magneton (μ_B) represents the electron's magnetic moment. It is a different force than the dipole magnet calculated in Section 3.4.

In the gravitational explanation of two electrons in Fig. 4.8.1, the wave amplitude and energy coming into the surface of the electron's sphere is not equal to its outgoing amplitude and energy. The difference is very slight as a result of motion of a center granule being displaced a Planck length. Due to the conservation of energy principle, there should be energy transferred as a result of this one-dimensional motion of the center granule. This is illustrated in the next figure.

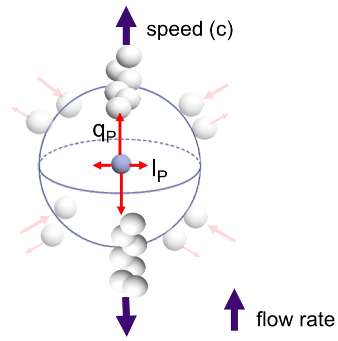

Fig. 4.9.1 – Flow rate of granules at two poles of a particle

Fig 4.9.1 shows the energy from this vibration flowing through the electron at two poles. But the Bohr magneton is not expressed in terms of either energy nor force. In the simplified kg/m/s unit system from Section 1, the Bohr magneton's units resolve to cubic meters per second (m^3/s) when the units of charge (Coulombs) are replaced with the units of distance (meters). These units make the Bohr magneton the equivalent of a flow rate, calculating the flow from one pole of the electron.

It is an outward flow only. The incoming energy is spherical, electric energy, vibrating the center granule and causing the flow. As a result, it is calculated as the wave speed (c) going through the cross section of the Planck charge (q_P) and Planck length (l_P) as described in Fig. 4.9.1. It shares the same geometric transformation as gravity, since it is the conservation of energy described in both Figs. 4.8.1 and 4.9.1, however, it becomes the square root of the gravitational coupling constant (α_{Ge}) because it is a one-way wave flow only (if it was c^2, then the square root would be removed). The equation that measures the flow from one pole of the electron (1/2) is the following:

$$\mu_B = \frac{1}{2} q_P l_P c \sqrt{\frac{1}{\alpha_{Ge}}} \quad \textbf{(4.9.1)}$$

Substitute from Eq. 2.2.3 to replace the gravitational coupling constant.

$$\mu_B = \frac{1}{2} q_P l_P c \sqrt{\frac{1}{\frac{l_P^2 \alpha}{r_e^2}}} \quad \textbf{(4.9.2)}$$

Simplify. The Planck charge and fine structure constant can be substituted for elementary charge, per Eq. 3.3.7. The Bohr magneton in correct units is a volumetric flow rate.

$$\mu_B = \frac{1}{2} \frac{q_P r_e c}{\sqrt{\alpha}} \quad \textbf{(4.9.3)}$$

$$\mu_B = \frac{1}{2}\frac{e_e r_e c}{\alpha} = 9.274 \cdot 10^{-24}\left(\frac{m^3}{s}\right) \quad \textbf{(4.9.4)}$$

Conclusion

It is the geometry of spacetime that defines particles and their motion. In this paper, it was shown that the structure of spacetime can be modeled as a body-centered cubic (bcc) lattice structure, where the repeating structure known as unit cells contain the properties discovered by Max Planck for the values of Planck mass, Planck length, Planck time and Planck charge. It is why the Planck unit system fits nicely into physics equations modeling energy and forces.

The unit cells of the spacetime lattice may expand and contract in harmonic motion, creating the presence of waves that form the basis of particles as standing waves and the forces that cause the motion of particles as traveling waves. All of which can be traced back to a single unit cell and the motion of its components, referred to here as granules, as they spread linearly or spherically due to the structure of the bcc unit cell.

The structure of spacetime was found to be similar in equation to a spring-mass system, allowing all calculations of energy and forces to be based on classical mechanics and properties where the components of the spacetime unit cell have a known position in time and space.

There are two ratios of geometric shapes that were found to be important in this paper. The ratio converting the surface area of a rectangle to the surface area of a sphere/cone combination provided the unification of forces as the coupling constants for the electric force compared to the strong force, gravitational force and magnetic force – all of which were the same geometry with differing lengths and widths of the cross-section of a rectangle. And the ratio converting the volume of a sphere to the volume of a pyramid was used to convert the magnetic constant from a particle's spherical properties to how it is measured at distance as a force.

The simplified unit system with three basic units (kg, m, s) and only five constants (Planck length, Planck mass, Planck time, Planck charge and electron radius) were used along with the geometry ratios established for forces and correctly derived and calculated more than a dozen fundamental physical constants associated with the electron. It includes proportionality constants such as the gravitational constant (G), the Planck constant (h) and the Rydberg constant (R_∞) which have been validated in physics equations across a wide range of measurements for gravitational forces, photon energies and photon wavelengths respectively, thus validating the simplified equations in this paper.

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