Fundamental Physical Constants:
Explained and Derived by Wave Equations

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Summary

There are many fundamental physical constants that appear in equations today, such as Planck's constant (h) to calculate photon energy, or Coulomb's constant (k) to calculate the electromagnetic force, or the gravitational constant (G), when using Newton's law for calculating gravitational force. They appear in equations without explanations. They are simply numbers that have been given letters to make an equation work.

This paper has derived and explained 18 different constants used in physics today, including the aforementioned Planck's constant, Coulomb's constant and gravitational constant. They have meaning. There is a reason that they reside in equations, and understanding these values unlocks a better understanding of the core of particle physics.

With the exception of one constant, all of the derived values are accurate to less than 0.13% of the difference from their currently accepted values, using recent CODATA values, and the values calculated in this paper. Many of the constants are an exact match with no difference (0.00%). The values were derived using new wave constants from the wave equations proposed within this paper, and the complementary *Particle Energy and Interaction*[1] and *Forces*[2] papers. Only the radius of the proton exceeds this accuracy at a difference of 1.41%, but note that the proton's exact value of its radius is subject to debate.[3]

The equations not only derive the correct value but also the units of the existing physical constant. Some of the calculations require an equivalent SI unit in wave theory to match units, such as charge needs to be measured in wave amplitude (in meters) instead of Coulombs, but all units align properly when this is exchanged. Only the Planck mass has a unit that did not meet expectations in the calculations (the square root of a meter instead of kilograms). Details to reproduce these values, including their units, are explained in this paper.

This paper also includes proposed models for the geometries of both the electron and the proton. The equations yield some descriptions about their characteristics and visuals are provided in this paper to explain these findings.

Eighteen common fundamental physical constants were solved in this paper. The method was scientific, starting with wave equations to model particle energies and forces. Many of today's physical constants appeared when modeling energies and forces using these wave equations. All 18 of these physical constants are documented as further proof that the wave equations are accurate and have the ability to calculate many of the characteristics of subatomic particles and their interactions with other particles.

1. Wave Constants

Eighteen fundamental physical constants are derived and explained by four wave constants in this paper: wave speed, wavelength, amplitude and density. Of these four constants, only wave speed is known in today's physical constants (the speed of light). This section details the new constants and their notation.

The fundamental physical constants are shown below in Table 1.1 with their current values (CODATA 2014)[4], along with **calculated values found in this paper**. Section 2 details the calculations and provides an explanation for most of the physical constants and why they appear in equations. Of these constants calculated, only the proton radius has a value that differs by greater than 0.13%.

Physical Constant	CODATA Value	Calculated	% Diff	Modifier
Fine Structure Constant	7.2974E-03	**7.2974E-03**	*0.000%*	
Electron Mass	9.1094E-31	**9.1094E-31**	*0.000%*	
Electron Classical Radius	2.8179E-15	**2.8179E-15**	*0.000%*	
Proton Radius	8.7516E-16	**8.6281E-16**	*1.411%*	
Bohr Radius	5.2918E-11	**5.2918E-11**	*0.000%*	
Electron Compton Wavelength	2.4263E-12	**2.4263E-12**	*0.000%*	Δ_e
Rydberg Constant (Joules)	2.1799E-18	**2.1799E-18**	*0.000%*	Δ_e^{-1}
Rydberg Constant (meters)	1.0974E+07	**1.0974E+07**	*0.000%*	Δ_e^{-1}
Planck Constant	6.6261E-34	**6.6261E-34**	*0.000%*	
Planck Time	5.3912E-44	**5.3912E-44**	*0.000%*	
Planck Length	1.6162E-35	**1.6183E-35**	*-0.129%*	$\Delta_{Ge}\Delta_e^2$
Planck Mass	2.1765E-08	**2.1738E-08**	*0.123%*	$\Delta_{Ge}\Delta_e^2$
Planck Charge	1.8755E-18	**1.8755E-18**	*0.002%*	$(\Delta_{Ge}\Delta_e)^{-1}$
Elementary Charge	1.6022E-19	**1.6021E-19**	*0.002%*	$(\Delta_{Ge}\Delta_e)^{-1}$
Coulomb Constant	8.9876E+09	**8.9880E+09**	*-0.005%*	$(\Delta_{Ge}\Delta_e)^2$
Electric Constant - Vacuum Perm.	8.8542E-12	**8.8537E-12**	*0.005%*	$(\Delta_{Ge}\Delta_e)^{-2}$
Magnetic Constant	1.2566E-06	**1.2567E-06**	*-0.005%*	$(\Delta_{Ge}\Delta_e)^2$
Bohr Magneton	9.2740E-24	**9.2738E-24**	*0.002%*	$(\Delta_{Ge}\Delta_e)^{-1}$
Gravitational Constant	6.6741E-11	**6.6741E-11**	*0.000%*	

Table 1.1 – Fundamental Physical Constants

Table 1.1 includes a column for the modifier that was used, if needed, for physical constants to offset the calculations using the wave equations. This is explained in Section 1.2.

1.1. Wave Equation Constants

Some of the constants and variables used to model the wave equations differ from standard physics and their use and notation needs to be established.

Notation

The wave equations include notation to simplify variations of energies and wavelengths at different particle sizes (K) and shells (n), in addition to differentiating longitudinal and transverse waves. The following notation is used:

Notation	Meaning
λ_l	l - longitudinal
λ_t	t - transverse
K_e	e – electron
$E_{(K)}$	Energy at particle wave center count (K)
$\lambda_{t(K,n)}$	Transverse wavelength at particle wave center count (K) and shell (n)

Table 1.1.1 – Wave Equation Notation

Constants and Variables

The following are the wave constants and variables used in the wave equations, including constants for the electron that are commonly used in this paper.

Symbol	Definition	Value (units)
Wave Constants		
A_l	Amplitude (longitudinal)	$3.662799228 \times 10^{-10}$ (m)
λ_l	Wavelength (longitudinal)	$2.817940327 \times 10^{-17}$ (m)
ρ	Density (aether)	$9.422329851 \times 10^{-30}$ (kg/m^3)
c	Wave velocity (speed of light)	299,792,458 (m/s)
Variables		
δ	Amplitude factor	variable - (m^3)

K	Particle wave center count	variable - *dimensionless*
n	Particle shells	variable - *dimensionless*
N	Particle orbits *(formerly n)*	variable - *dimensionless*
Q	Particle count in a group	variable - *dimensionless*
	Electron Constants	
δ_e	Amplitude factor – single electron	0.9936344 - (m^3)
δ_{Ge}	Amplitude factor – Gravity of electron	0.9827420 - (m^3)
K_e	Particle wave center count - electron	10 - *dimensionless*
O_e	Shell energy multiplier – electron	2.138743820 - *dimensionless*

Table 1.1.2 – Wave Equation Constants and Variables

1.2. Wave Equation Modifiers

The wave equations make assumptions of perfect spherical volumes for particles and cylindrical volumes for photons, in addition to perfect constructive and destructive wave interference for amplitude, meaning that wave centers must be placed at exact wavelengths in geometric formation when creating particles. In reality, the experimental data shows slight imperfections in the wave constants.

The wave equations match experimental data and show the validity of the equations for calculating: particle mass and energy, atomic orbitals, electromagnetic wavelengths and energy during particle interaction, the electromagnetic force, gravitational force and strong force. All of the above equations and examples were illustrated in the *Particle Energy and Interaction* and *Forces* papers. To match existing data, two amplitude factors for the electron (δ_e and δ_{Ge}) were modified from their expected values of 1, to 0.9934344 and 0.9827420 respectively, to account for imperfections in volume and constructive wave interference. For example, a particle may not be a perfect sphere due to spin, or in certain three dimensional geometries, it may be impossible to place wave centers exactly at nodes on a wavelength, relative to each other.

For the purpose of calculating some of the fundamental physical constants, the imperfections accounted for in the wave equation amplitude factors need to be applied as modifiers in the derivations of the physical constants. They are the same values as the two electron amplitude factors described in Section 1.1, but listed separately as a modifier, one that is dimensionless (no units), for the purpose of deriving the physical constants.

Symbol	Definition	Value (units)
	Modifiers	
Δ_e	Modifier – single electron	Same as δ_e - *dimensionless*

Δ_{Ge}	Amplitude factor – Gravity electron	Same as δ_{Ge} - *dimensionless*

2. Fundamental Physical Constants - Derived and Explained

There are dozens of physical constants that are used in calculations in physics today, many of which have a value and solve an equation, yet have no meaning or explanation of its value. While developing the wave equations proposed herein, some of these fundamental physical constants could be derived and explained.

The explanation of the equations for energy, wavelength and forces are available in the *Particle Energy and Interaction* and the *Forces* papers, but in this paper, the physical constants will be explained and derived using the four wave constants and constant properties of the electron (where applicable).

2.1. Electron Energy and Mass

Electron Rest Energy

Electron energy and mass were derived from the Longitudinal Energy Equation, responsible for particle energy, in the *Particle Energy and Interaction* paper. Particles are standing, longitudinal waves with amplitudes that decrease with the square of the distance from the particle core. Particles consist of wave centers (K) that reflect incoming waves (in-waves), perhaps like a three-dimensional mirror that reflects and creates spherical out-waves that are responsible for its standing waves. A special particle appears at K=10 (10 wave centers in the core) matching the electron's rest energy and mass.

$$E_e = E_{l(10)} = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.1.1)}$$

Calculated Value: 8.1871E-14
Difference from CODATA: 0.000%
Calculated Units: Joules (kg m^2/s^2)

Electron Rest Mass

Electron rest mass is the same Longitudinal Energy Equation, without c^2 in the equation. Mass is simply standing, longitudinal waves of energy.

$$m_e = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.1.2)}$$

Calculated Value: 9.1094E-31
Difference from CODATA: 0.000%
Calculated Units: kg

Shell Energy Multiplier

The energy equation appears or is used to derive many of the fundamental physical constants, and since the summation in the equation remains constant for the electron, it is given a special constant (O_e) for readability purposes when the calculation is used for the electron. The short form will be used in subsequent equations and derivations. In other words:

$$E_e = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \tag{2.1.3}$$

$$E_e = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2}{3\lambda_l^3} O_e \tag{2.1.4}$$

2.2. Electron Radius

Particles have a defined radius as eventually its standing waves, which defines its mass and potential energy, converts to traveling waves at this edge (radius). Traveling waves still have an effect on other particles although amplitude decreases with the square of the distance from the core. The electron has 10 wave centers (K=10), and these wave centers have an effect on the particle's wavelength and amplitude. Amplitude is constructive, and becomes K * A_l (amplitude); likewise wavelength becomes K * λ_l (wavelength). There are a total of K standing waves in each particle, so for the electron, this is 10 wavelengths, or K wavelengths. Thus the radius becomes the number of wavelengths K, multiplied by the electron wavelength distance in meters, K * λ_l. This is $K^2\lambda_l$

The electron has been modeled in Section 3.1, along with visuals of the proposed geometry of the particle and a comparison against pictures of the electron.

$$r_e = K_e^2 \lambda_l \tag{2.2.1}$$

Calculated Value: 2.8179E-15
Difference from CODATA: 0.000%
Calculated Units: meters (m)

2.3. Proton Radius

In this wave theory, the proton has a different structure than the currently accepted structure consisting of three quarks. Note that Section 3.2 includes an explanation of the strong force color and an explanation of why quarks are found in proton collisions from particle accelerator experiments. This paper calculates the radius of the proton based on a new proposed structure, which has been modeled in Section 3.2 matching these equations.

The proton radius is based on four electrons in a tetrahedral shape. At a separation distance of one electron wavelength ($K\lambda_l$), it forms a strong bond (gluons) due to constructive wave interference of four electrons. This creates a new amplitude and core, explaining why electrons are not repelled at this distance (they form a new core). The original electrons lose their individual standing waves as they form a new particle. The original radius of $K^2\lambda_l$ meters is now only one-electron wavelength $K\lambda_l$ meters. $K\lambda_l$ is the electron core radius.

The radius to the circumpshere of a tetrahedral shape is used below in the calculation, with variable (a) as the length of the base (the calculation of radius is the square root of 3/8 * a). At the base of one edge of the tetrahedron are two electrons. They both have a radius of $K\lambda_l$, or 2 $K\lambda_l$ in diameter. Two electrons with this diameter, separated by one electron wavelength is: $2K\lambda + 2K\lambda + K\lambda$, $= 5K\lambda$ meters in length for the base of the tetrahedron. Now, the following equations model the radius of the particle with this base (a):

$$a = 5K_e\lambda_l \qquad \textbf{(2.3.1)}$$

$$r_p = \sqrt{\frac{3}{8}} \cdot a \qquad \textbf{(2.3.2)}$$

$$r_p = \sqrt{\frac{3}{8}} \cdot 5K_e\lambda_l \qquad \textbf{(2.3.3)}$$

Calculated Value: 8.6281E-16
Difference from CODATA: 1.411%
Calculated Units: meters (m)

Note: No modifier has been used in the calculation of the proton. Its value differs from the CODATA value of 8.7516E-16, but the radius of the proton is subject to debate. Various experiments have a range of 8.4E-16 to 8.7E-16 m.[5]

2.4. Bohr Radius

The Bohr radius is based on the fine structure constant (α), which is derived later in this paper and thus not required as a separate constant for the wave equations. For the purpose of equation readability, its symbol will be used.

The distance for the first orbital shell (N=1) in hydrogen (Bohr radius) along with all the orbital shells of hydrogen were derived and calculated in the *Particle Energy and Interaction* paper. It can be modeled as the distance, in wavelengths, proportional to the square of the fine structure constant.

First, the number of wavelengths, or shells (n), are modeled. To get the number of wavelengths for the first orbital shell, the following is used:

$$N = 1 \qquad \textbf{(2.4.1)}$$

$$n_N = K_e \left(\frac{N}{\alpha_e}\right)^2 \qquad \textbf{(2.4.2)}$$

$$n_1 = K_e \left(\frac{1}{\alpha_e}\right)^2 \qquad \textbf{(2.4.3)}$$

$\mathbf{n_1}$**=**187,779 wavelengths

This provides the number of wavelengths from the atom's core. However, the Bohr radius is measured in meters. It needs to be multiplied by the number of electron wavelengths ($K\lambda_l$):

$$a_0 = n_1 K_e \lambda_l \qquad \textbf{(2.4.4)}$$

Calculated Value: 5.2918E-11
Difference from CODATA: 0.000%
Calculated Units: meters (m)

2.5. Electron Compton Wavelength

The electron Compton wavelength is derived from the Transverse Wavelength Equation, also illustrated in the *Particle Energy and Interaction* paper. Because the Compton wavelength is when all of the energy of the electron is transferred from rest mass energy to photon energy, and since there are two photons generated, it occurs at n=K/2, or 5 wavelengths for the electron (the electron is K=10).

$$n_e = 5 \qquad \textbf{(2.5.1)}$$

$$\lambda_{C(10,5)} = \frac{4\,(n_e)\,A_l}{3\,(K_e)^3} \quad \textbf{(2.5.2)}$$

Calculated Value: 2.4419E-12
Difference from CODATA: -0.641%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the dimensionless amplitude factor for the electron.

$$\lambda_{C'} = \frac{4\,(n_e)\,A_l}{3\,(K_e)^3}\,(\Delta_e) \quad \textbf{(2.5.4)}$$

Calculated Value: 2.4263E-12
Difference from CODATA: 0.000%
Calculated Units: meters (m)

2.6. Rydberg Constants

The Rydberg Constant (meters)

The Rydberg constant was derived from the Transverse Wavelength Equation in the *Particle Energy and Interaction* paper. It is used to determine photon wavelengths. During the derivation of the Transverse Wavelength equation, it was noticed that amplitude was related to the fine structure constant, shown in Eq. 2.6.1. Since the fine structure constant can also be derived (it is found in Section 2.18), it can replace the value in Eq. 2.6.1 to solve for the Rydberg constant in terms of wave constants and electron constants.

$$R_\infty = \frac{3K_e^2\alpha_e^2}{4A_l} \quad \textbf{(2.6.1)}$$

$$R_{\infty} = \frac{3K_e^2}{4A_l}\left(\frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e}\right)^2 \qquad \textbf{(2.6.2)}$$

$$R_{\infty} = \frac{3\pi^2 K_e^{10} A_l^{11} O_e^2}{4\lambda_l^6 \delta_e^2} \qquad \textbf{(2.6.3)}$$

Calculated Value: 1.0904E+07
Difference from CODATA: 0.637%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the inverse of the dimensionless amplitude factor for the electron.

$$R_{\infty'} = \frac{3\pi^2 K_e^{10} A_l^{11} O_e^2}{4\lambda_l^6 \delta_e^2}\left(\frac{1}{\Delta_e}\right) \qquad \textbf{(2.6.3)}$$

Calculated Value: 1.0974E+07
Difference from CODATA: 0.000%
Calculated Units: m^{-1}

Rydberg Unit of Energy Constant (Joules)

Similar to above, the Rydberg Unit of Energy constant appears in the Transverse Energy equation. Its value, in relation to all four wave constants and electron constants, is as follows. In the second equation, the fine structure constant is removed and replaced with its derived value from Section 2.18:

$$R_y = \frac{2\pi\delta_e \boldsymbol{\rho} \lambda_l K_e^5 c^2 \alpha_e^2}{A_l} \qquad \textbf{(2.6.4)}$$

$$R_y = \frac{2\pi\delta_e \boldsymbol{\rho} \lambda_l K_e^5 c^2}{A_l} \left(\frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e} \right)^2 \qquad \textbf{(2.6.5)}$$

$$R_y = \frac{2\pi^3 \boldsymbol{\rho} K_e^{13} A_l^{11} c^2 O_e^2}{\lambda_l^5 \delta_e} \qquad \textbf{(2.6.6)}$$

Calculated Value: 2.1660E-18
Difference from CODATA: 0.637%

Modifier

Like the Rydberg Constant for wavelength, it requires the same modifier - the inverse of the dimensionless amplitude factor for the electron.

$$R_{y'} = \frac{2\pi^3 \boldsymbol{\rho} K_e^{13} A_l^{11} c^2 O_e^2}{\lambda_l^5 \delta_e} \left(\frac{1}{\Delta_e} \right) \qquad \textbf{(2.6.7)}$$

Calculated Value: 2.1799E-18
Difference from CODATA: 0.000%
Calculated Units: Joules (kg m^2/s^2)

2.7. Planck Constant

Planck constant is another fundamental physical constant that was derived with the Transverse Energy Equation in the *Particle Energy and Interaction* paper. The Planck constant appears as a combination of wave constant values when solving for energy when transverse wavelength (or frequency) is variable. This is shown in Eq. 2.7.1 below. The value on the right is the only variable, which is the inverse of transverse wavelength, based on the value of K (normally 10 for an electron) and n (its current shell).

It's responsible for the famous equation E=hf, so a comparison has been shown in Eq. 2.7.2 to illustrate the constants and variables in this equation. Frequency (f) is the wave speed c over the variable wavelength (Eq. 2.7.3). Thus the constants that remain, including one value of c, not two, becomes the constants seen in the Planck Constant (Eq. 2.7.4).

$$E_{t(K,n)} = \frac{8}{3}\pi\boldsymbol{\rho} K^3 \lambda_l c^2 \delta \frac{1}{\lambda_{t(K,n)}} \qquad \textbf{(2.7.1)}$$

$$E = hf \qquad \textbf{(2.7.2)}$$

$$f = \frac{c}{\lambda_{t(K,n)}} \qquad \textbf{(2.7.3)}$$

$$h = \frac{8}{3}\pi\boldsymbol{\rho} K_e^3 \lambda_l c \delta_e \qquad \textbf{(2.7.4)}$$

Calculated Value: 6.6261E-34
Difference from CODATA: 0.000%
Calculated Units: kg m^2 / s

2.8. Planck Length

While working on gravity, it was realized that Planck length and the mass of the electron were related to the new Force Equation. The following equation on force was discovered which includes Planck length (Eq. 2.8.1). It was set equal to the Force Equation (Eq. 2.8.2), which is described in the *Forces* paper. Eq. 2.8.3 shows the combination of force equations to solve for Planck length. Finally, in Eq. 2.8.4, the derivation of electron mass was already solved in Section 2.1 and replaced into the equation.

$$F = \frac{l_P m_e c^2 (K_e^3 A_l)^2}{\lambda_l^2 r^2} \qquad \textbf{(2.8.1)}$$

$$F = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} \left(\frac{K_e^2 \lambda_l}{r^2} \right) \qquad \textbf{(2.8.2)}$$

$$\frac{l_P m_e c^2 (K_e^3 A_l)^2}{\lambda_l^2 r^2} = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3}\left(\frac{K_e^2 \lambda_l}{r^2}\right) \tag{2.8.3}$$

$$\frac{l_P\left(\frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 O_e}{3\lambda_l^3}\right) c^2 (K_e^3 A_l)^2}{\lambda_l^2 r^2} = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3}\left(\frac{K_e^2 \lambda_l}{r^2}\right) \tag{2.8.4}$$

Now, Planck length is the only variable, because radius will drop from both sides of the equation. Thus the equation can be solved for Planck length. It reduces to a simple value where it's related to the cube of wavelength over the square of amplitude. One potential explanation is that it is the smallest energy (amplitude squared) in a three dimensional cube. Other suggestions have been that Planck length is the smallest possible length. Either way, it still resolves to units in meters and is consistent with calculations.

$$l_P = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2 O_e}{3(\lambda_l^3)}\left(\frac{K_e^2 \lambda_l}{r^2}\right)\frac{3\lambda_l^3 \lambda_l^2 r^2}{4\pi\boldsymbol{\rho} K_e^5 A_l^6 O_e c^2 (K_e^3 A_l)^2} \tag{2.8.5}$$

$$l_P = \frac{\lambda_l^3}{K_e^4 A_l^2} \tag{2.8.6}$$

Calculated Value: 1.6679E-35
Difference from CODATA: -3.197%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the dimensionless amplitude factor for the electron squared and the dimensionless amplitude factor for the gravity of the electron.

$$l_{P'} = \frac{\lambda_l^3}{K_e^4 A_l^2} (\Delta_{Ge} \Delta_e^2) \tag{2.8.7}$$

Calculated Value: 1.6183E-35
Difference from CODATA: -0.129%
Calculated Units: meters (m)

2.9. Planck Mass

Planck mass is thought to be the maximum possible mass capable of holding a single elementary charge.[6] It shows up in equations for black holes, with the potential to spontaneously create a black hole. As a mass, it would therefore be expected to show up in these equations in units of kg. But this is one constant that does not match standard SI units in these calculations.

While working on gravity, it was realized that Planck mass was related to the fine structure constant for the electromagnetic force. Planck mass is the point where amplitude is fully absorbed so that amplitude difference between particles is at a maximum. This was found in Eq. 2.9.1.

$$\frac{A_l}{K_e^8 m_P^2} = \alpha_e \tag{2.9.1}$$

$$m_P = \sqrt{\frac{A_l}{K_e^8 \alpha_e}} \tag{2.9.2}$$

The fine structure constant was derived later in this paper in Section 2.18, so it can be added back into Eq. 2.9.2.

$$m_P = \sqrt{\frac{A_l}{K_e^8 \left(\frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e} \right)}} \tag{2.9.3}$$

$$m_P = \sqrt{\frac{\lambda_l^3 \delta_e}{\pi K_e^{12} A_l^5 O_e}} \quad \textbf{(2.9.4)}$$

Calculated Value: 2.2404E-08
Difference from CODATA: -2.937%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the dimensionless amplitude factor for the electron squared and the dimensionless amplitude factor for the gravity of the electron.

$$m_{P'} = \sqrt{\frac{\lambda_l^3 \delta_e}{\pi K_e^{12} A_l^5 O_e}} \cdot (\mathit{\Delta}_{Ge} \mathit{\Delta}_e^2) \quad \textbf{(2.9.5)}$$

Calculated Value: 2.1738E-08
Difference from CODATA: 0.123%
Calculated Units: $m^{1/2}$

Note: Units do not match. The equation above is measured in the square root of a meter, not kg, which is expected for a mass.

2.10. Planck Time

The derivation of Planck time came from the current physics explanation as the square root of the reduced Planck constant and gravitational constant G over c^5. However, why is c^5 in the equation for the current explanation? The square root would not produce units of seconds, so it must be hidden in h or G, thus these constants are not fundamental. Although no new explanation of Planck Time is given here, it will be assumed that it is the smallest unit of time.

Eq. 2.10.2 expands Eq. 2.10.1 based on values of h and G derived here in this paper.

$$t_p = \sqrt{\frac{hG}{2\pi c^5}} \quad \textbf{(2.10.1)}$$

$$t_P = \sqrt{\left(\frac{8}{3}\pi\boldsymbol{\rho}K_e^3\lambda_l c\delta_e\right)\left(\frac{3K_e^5\lambda_l^{11}c^2\delta_e}{4\pi^2\boldsymbol{\rho}A_l^{13}O_e^2\delta_{Ge}}\right)\left(\frac{1}{2\pi}\right)\left(\frac{1}{c^5}\right)} \qquad \textbf{(2.10.2)}$$

The equation can now be simplified to wave constants and known properties of the electron.

$$t_P = \sqrt{\frac{K_e^8\lambda_l^{12}\delta_e^2}{\pi^2A_l^{13}c^2O_e^2\delta_{Ge}}} \qquad \textbf{(2.10.3)}$$

$$t_P = \frac{K_e^4\lambda_l^6\delta_e}{\pi c O_e}\sqrt{\frac{1}{A_l^{13}\delta_{Ge}}} \qquad \textbf{(2.10.4)}$$

Calculated Value: 5.3912E-44
Difference from CODATA: 0.000%
Calculated Units: s (time in seconds)

2.11. Planck Charge

It is known in physics that Planck charge is related to the elementary charge and the fine structure constant. After solving Planck mass, it was realized that Planck charge is related to the square of Planck mass, without the fine structure constant. Charge is based on amplitude. As particles interact with each other, they constructively or destructively combine waves that affect amplitude. Charge is based on wave amplitude in meters, not Coulombs.

$$q_P = \frac{A_l}{2K_e^8} \qquad \textbf{(2.11.1)}$$

Calculated Value: 1.8314E-18
Difference from CODATA: 2.354%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the inverse of the dimensionless amplitude factor for the electron and the dimensionless amplitude factor for the gravity of the electron.

$$q_{P'} = \frac{A_l}{2K_e^8}\left(\frac{1}{\Delta_{Ge}\Delta_e}\right) \tag{2.11.2}$$

Calculated Value: 1.8755E-18
Difference from CODATA: 0.002%
Calculated Units: m

Note: Units are in meters, not Coulombs (C), as wave theory measures charge based on amplitude, which is in meters.

2.12. Elementary Charge

The elementary charge was derived from known physics equations relating it to the Planck charge and the square root of the fine structure constant. Both of these constants can be replaced with wave constants from values derived in this paper. Note that the elementary charge (e) has been given a subnotation "e", i.e. e_e. Similar to Planck charge, amplitude is responsible for charge and measured in meters.

$$e_e = q_P\sqrt{\alpha_e} \tag{2.12.1}$$

$$e_e = \frac{A_l}{2K_e^8}\sqrt{\alpha_e} \tag{2.12.2}$$

Expand the fine structure constant and solve.

$$e_e = \frac{A_l}{2K_e^8}\sqrt{\left(\frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e}\right)} \tag{2.12.3}$$

$$e_e = \frac{A_l^4}{2K_e^6}\sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e}\right)} \tag{2.12.4}$$

Calculated Value: 1.5645E-19
Difference from CODATA: 2.354%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the inverse of the dimensionless amplitude factor for the electron and the dimensionless amplitude factor for the gravity of the electron.

$$e_{e'} = \frac{A_l^4}{2K_e^6}\sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e}\right)} \cdot \left(\frac{1}{\Delta_{Ge}\Delta_e}\right) \tag{2.12.5}$$

Calculated Value: 1.6021E-19
Difference from CODATA: 0.002%
Calculated Units: m

Note: Units are in meters, not Coulombs (C), as wave theory measures charge based on amplitude, which is in meters.

2.13. Coulomb Constant

The Coulomb constant (k) is derived from the Force Equation (also shown in the *Forces* paper). It is the combination of wave constants in the equation as only amplitude and distance are variables in the Force Equation for electromagnetism, thus it is shown as one constant in current physics equations. In reality, it is a combination of wave constants. The variable that affects force is amplitude (because wave centers move to minimize amplitude), and since longitudinal amplitude decreases with the square of distance, it is also seen in the equation.

The Force Equation is shown in Eq. 2.13.1. It is essentially the Longitudinal Energy Equation (particle energy) multiplied by the distance to the particle's radius where standing waves convert to traveling waves (at $K^2\lambda_l$). In short, it is the energy that is required to move the wave centers at the core of the particle to the particle's edge (radius), where it would transition from potential energy to kinetic energy. The distance, r^2, appears because of the effect of the amplitude from the second object exerting the force on the first object. This is explained in great detail in the *Forces* paper.

Eq. 2.13.2 simplifies the original Force Equation and separates amplitude and distance, as these are variables. It was shown in the *Forces* paper to match experimental data in electromagnetism using wave constants (without the Coulomb constant).

$$F = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2 O_e}{3\,(\lambda_l^3)} \left(\frac{K_e^2 \lambda_l}{r^2} \right) \tag{2.13.1}$$

$$F = \frac{4\pi\boldsymbol{\rho} K_e^7 c^2 O_e}{3\lambda_l^2}\,(A_l^6) \left(\frac{1}{r^2} \right) \tag{2.13.2}$$

In current physics, the electromagnetic forces are calculated using the Coulomb constant as follows in Eq. 2.13.3. For the purpose of deriving the Coulomb constant, two electrons of a single charge (e) will be used. Thus, the simplified equation in Eq. 2.13.4.

$$F = k_e\,(q_1 q_2) \left(\frac{1}{r^2} \right) \tag{2.13.3}$$

$$F = k_e\,(e_e^2) \left(\frac{1}{r^2} \right) \tag{2.13.4}$$

Eqs. 2.13.4 and 2.13.2 are set equal to each other since the force calculations were proven to equal in the *Forces* paper. Distance (r) will drop from the equation so that Coulomb constant (k) can be solved in Eq. 2.13.6.

$$k_e\,(e_e^2) \left(\frac{1}{r^2} \right) = \frac{4\pi\boldsymbol{\rho} K_e^7 c^2 O_e}{3\lambda_l^2}\,(A_l^6) \left(\frac{1}{r^2} \right) \tag{2.13.5}$$

$$k_e = \frac{4\pi\boldsymbol{\rho} K_e^7 c^2 O_e}{3\lambda_l^2} \frac{A_l^6}{e_e^2} \tag{2.13.6}$$

Next, the elementary charge derived earlier can be replaced in Eq. 2.13.6 to solve for the Coulomb constant.

$$k_e = \frac{4\pi\boldsymbol{\rho} K_e^7 c^2 O_e}{3\lambda_l^2} \frac{A_l^6}{\left(\frac{A_l^4}{2K^6}\sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e}\right)}\right)^2} \tag{2.13.7}$$

$$k_e = \frac{16\boldsymbol{\rho} K_e^{19} \lambda_l c^2 \delta_e}{3A_l^2} \tag{2.13.8}$$

Calculated Value: 9.4261E+9
Difference from CODATA: -4.879%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the square of both the dimensionless amplitude factor for the electron and the dimensionless amplitude factor for the gravity of the electron.

$$k_{e'} = \frac{16\boldsymbol{\rho} K_e^{19} \lambda_l c^2 \delta_e}{3A_l^2} (\mathit{\Delta}_{Ge} \mathit{\Delta}_e)^2 \tag{2.13.9}$$

Calculated Value: 8.9880E+9
Difference from CODATA: 0.005%
Calculated Units: kg m / s^2

Note: The above units are based in kg * m/s^2. By comparison the Coulomb constant (k) is measured in N * m^2/C^2. However, in wave theory C (Coulombs) are measured in m (meters) as charge is based on amplitude. N (Newtons) can be expressed in kg * m/s^2, so when N is expanded and C is represented by meters, it resolves to the correct units expected for the Coulomb constant. The derivation of units from the current Coulomb constant to the wave theory version is as follows:

$$\frac{Nm^2}{C^2} = \frac{kg\,(m)}{s^2}\frac{m^2}{m^2} = \frac{kg\,(m)}{s^2} \tag{2.13.10}$$

2.14. Electric Constant (Vacuum Permittivity)

The electric constant is the inverse of 4*π k (Coulomb constant). Thus, this value is derived based on the Coulomb constant found in Section 2.13.

$$\varepsilon = \frac{1}{4\pi k_e} \qquad \textbf{(2.14.1)}$$

$$\varepsilon_0 = \frac{1}{4\pi\left(\frac{16\boldsymbol{\rho} K_e^{19}\lambda_l c^2\delta_e}{3A_l^2}\right)} \qquad \textbf{(2.14.2)}$$

$$\varepsilon_0 = \frac{3A_l^2}{64\pi\boldsymbol{\rho} K_e^{19}\lambda_l c^2\delta_e} \qquad \textbf{(2.14.3)}$$

Calculated Value: 8.4423E-12
Difference from CODATA: 4.652%

Modifier

The modifier in this case is the inverse of the square of both the dimensionless amplitude factor for the electron and the dimensionless amplitude factor for the gravity of the electron.

$$\varepsilon_{0'} = \frac{3A_l^2}{64\pi\boldsymbol{\rho} K_e^{19}\lambda_l c^2\delta_e}\frac{1}{(\Delta_{Ge}\Delta_e)^2} \qquad \textbf{(2.14.4)}$$

Calculated Value: 8.8537E-12
Difference from CODATA: 0.005%
Calculated Units: s^2 / kg m

Note: See Section 2.13 for an explanation of the Coulomb constant units. When C (Coulombs) is adjusted to be m (meters), the units align as expected.

2.15. Magnetic Constant (Vacuum Permeability)

The magnetic constant is related to the inverse of the electric constant multiplied by c^2. Thus, it is derived based on the value found in Section 2.14.

$$\mu = \frac{1}{\varepsilon_0 c^2} \qquad \textbf{(2.15.1)}$$

$$\mu_0 = \frac{1}{\left(\dfrac{3A_l^2}{64\pi\boldsymbol{\rho} K_e^{19}\lambda_l c^2 \delta_e}\right) c^2} \qquad \textbf{(2.15.2)}$$

$$\mu_0 = \frac{64\pi\boldsymbol{\rho} K_e^{19}\lambda_l \delta_e}{3A_l^2} \qquad \textbf{(2.15.3)}$$

Calculated Value: 1.3180E-6
Difference from CODATA: -4.879%

Modifier

The modifier in this case is the square of both the dimensionless amplitude factor for the electron and the dimensionless amplitude factor for the gravity of the electron.

$$\mu_{0'} = \frac{64\pi\boldsymbol{\rho} K_e^{19}\lambda_l \delta_e}{3A_l^2} (\Delta_{Ge}\Delta_e)^2 \qquad \textbf{(2.15.4)}$$

Calculated Value: 1.2567E-6
Difference from CODATA: -0.005%
Calculated Units: kg / m

Note: The units are measured in kg / m compared with H / m for the Magnetic Constant, where H is Henries. There isn't an equivalent for Henries in wave theory so it is assumed it is equivalent to kg to match the units.

2.16. Bohr Magneton

The Bohr Magneton is derived from known physics equations, however, replacing previous constants with ones that have been derived above with their wave equation equivalents. The elementary charge, Planck constant and electron mass are all replaced with equivalents derived above in Sections 2.11, 2.7 and 2.1 respectively.

$$\mu = \frac{eh}{4\pi m_e} \tag{2.16.1}$$

$$\mu_B = \frac{\left(\frac{A_l^4}{2K_e^6}\sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e}\right)}\right)\left(\frac{8}{3}\pi \boldsymbol{\rho} K_e^3 \lambda_l c \delta_e\right)}{4\pi\left(\frac{4\pi \boldsymbol{\rho} K_e^5 A_l^6}{3\lambda_l^3} O_e\right)} \tag{2.16.2}$$

$$\mu_B = \frac{c}{4K_e^8 A_l^2}\sqrt{\frac{\lambda_l^5 \delta_e}{\pi O_e}} \tag{2.16.3}$$

Calculated Value: 9.0557E-24
Difference from CODATA: 2.354%

Modifier

As explained in Section 1.2, some of the physical constants require a modifier to readjust the imperfections in the wave constants. The modifier in this case is the inverse of both the dimensionless amplitude factor for the electron and the dimensionless amplitude factor for the gravity of the electron.

$$\mu_{B'} = \frac{c}{4K_e^8 A_l^2}\sqrt{\frac{\lambda_l^5 \delta_e}{\pi O_e}} \cdot \frac{1}{\Delta_{Ge}\Delta_e} \tag{2.16.4}$$

Calculated Value: 9.2738E-24
Difference from CODATA: 0.002%
Calculated Units: m^3 / s

Note: The above units are based in m^3/s. By comparison the Bohr Magneton is measured in J/T (Joules per Tesla). Joules are measured in kg * m^2/s^2. A Tesla is measured in kg / (C * s). Again, C is measured in meters in wave theory as charge is based on amplitude. When this is replaced, expected units align. The derivation of units from the current Bohr Magneton to the wave theory version is as follows:

$$\frac{J}{T} = \frac{kg\frac{m^2}{s^2}}{\frac{kg}{Cs}} = \frac{kg\frac{m^2}{s^2}}{\frac{kg}{(m)\,s}} = \frac{m^3}{s} \qquad \textbf{(2.16.5)}$$

2.17. Gravitational Constant

The gravitational constant comes from the Force Equation (refer to the *Forces* paper) with a gravitational coupling (α_{Ge}) that is a reduction of amplitude for each particle slightly losing energy when reflecting in-waves to out-waves. The subnotation for the gravitational coupling is Ge - "G" for gravity and "e" for the electron.

$$F = \frac{4\pi\boldsymbol{\rho} K_e^7 c^2 A_l^6 O_e}{3\lambda_l^2}\frac{Q_1 Q_2}{r^2}(\alpha_{Ge}) \qquad \textbf{(2.17.1)}$$

The gravitational coupling was chosen to represent the equation to be consistent with previous experiments that demonstrate the strength of electromagnetism versus gravity for two electrons. The value for the gravitational coupling found in Eq. 2.17.2 is consistent with experiments, as it shows that gravity is 2.3 E-43 weaker than electromagnetism for two electrons. However, the equation also could have been modeled as an amplitude factor, as coupling and amplitude factor are related for gravity in Eq. 2.17.2. Gravity is a reduction in amplitude, which affects wave centers that will move to minimize amplitude, thus attracting particles together. Gravitational coupling for the electron is as follows:

$$\alpha_{Ge} = \frac{K_e^{12}\lambda_l^4}{A_l\delta_{Ge}\alpha_e} \qquad \textbf{(2.17.2)}$$

Gravitational Coupling: 2.4005E-43

Next, the gravitational coupling constant in Eq. 2.17.2 can be added back into the Force Equation in Eq. 2.17.1. The variables Q1, Q2 and r have been isolated for convenience as they are variable. Eq. 2.17.4 is a simplified version of Eq. 2.17.3.

$$F = \frac{4\pi\boldsymbol{\rho} K_e^7 c^2 A_l^6 O_e}{3\lambda_l^2}\left(\frac{Q_1 Q_2}{r^2}\right)\left(\frac{K_e^{12}\lambda_l^4}{A_l \delta_{Ge} \alpha_e}\right) \qquad \textbf{(2.17.3)}$$

$$F = \frac{4\pi\boldsymbol{\rho} K_e^{19} A_l^5 c^2 \lambda_l^2 O_e}{3\delta_{Ge}\alpha_e}\left(\frac{Q_1 Q_2}{r^2}\right) \qquad \textbf{(2.17.4)}$$

Eq. 2.17.4 is the force equation for gravity. To solve for the gravitational constant (G), the equation can be set equal to Newton's version of the gravity equation, where F=G*mm/r^2. In this case, the mass of two electrons will be used to set the two equations equal, or m_e^2.

$$F = \frac{4\pi\boldsymbol{\rho} K_e^{19} A_l^5 c^2 \lambda_l^2 O_e}{3\delta_{Ge}\alpha_e}\left(\frac{Q_1 Q_2}{r^2}\right) = \frac{G\,(m_e)^2}{r^2} \qquad \textbf{(2.17.5)}$$

On the left side of the equation (the wave equation force for gravity), Q1 and Q2 are set to one, since it is based on two electrons (one for Q1; one for Q2). This equals the force of Newton's gravitational formula for the mass of two electrons. Since the mass of the electron was solved in Section 2.1, it can be replaced in the equation. Also, the fine structure constant can be replaced with a value found in Section 2.18.

$$F = \frac{4\pi\boldsymbol{\rho} K_e^{19} A_l^5 c^2 \lambda_l^2 O_e}{3\delta_{Ge}\left(\frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e}\right)}\left(\frac{(1)\ (1)}{r^2}\right) = \frac{G\left(\frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6}{3\lambda_l^3} O_e\right)^2}{r^2} \qquad \textbf{(2.17.6)}$$

Now, the gravitational constant (G) can be isolated as shown in Eq. 2.17.7, and finally simplified in Eq. 2.17.8. Note that the value and units of G match the existing CODATA value.

$$G = \frac{4\pi\boldsymbol{\rho} K_e^{19} A_l^5 c^2 \lambda_l^2 O_e}{3\delta_{Ge}\left(\dfrac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e}\right)} \left(\frac{(1)\ (1)}{r^2}\right) \frac{(r^2)}{\left(\dfrac{4\pi\boldsymbol{\rho} K_e^5 A_l^6}{3\lambda_l^3} O_e\right)^2} \tag{2.17.7}$$

$$G = \frac{3K_e^5 \lambda_l^{11} c^2 \delta_e}{4\pi^2 \boldsymbol{\rho} A_l^{13} O_e^2 \delta_{Ge}} \tag{2.17.8}$$

Calculated Value: 6.6741E-11
Difference from CODATA: 0.000%
Calculated Units: $m^3 / s^2\ kg$

2.18. Fine Structure Constant

The fine structure constant appears in many physics equations and is an essential part of many calculations. In wave theory, the fine structure constant is the mass of the electron when the amplitude factor is (4/3) * Kρ. It's unclear why this is the case, but one potential explanation is resonance. There are other similarities with the fine structure constant and resonance that can be found in the Appendix. Here, the derivation is based on a known equation for the fine structure constant from current physics (Eq. 2.18.1), using the elementary charge (e), electric constant (ε), Planck constant (h) and speed of light (c), which are all derived above. These values replace the known physical constant values in Eq. 2.18.2, which is then simplified to find the fine structure constant in Eq. 2.18.3.

$$\alpha = \frac{e^2 2\pi}{4\pi\varepsilon h c} \tag{2.18.1}$$

$$\alpha_e = \frac{2\pi}{4\pi}\left(\frac{A_l^4}{2K_e^6}\sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e}\right)}\right)^2 \frac{64\pi\boldsymbol{\rho} K_e^{19} \lambda_l c^2 \delta_e}{3A_l^2} \frac{3}{8\pi\delta_e \boldsymbol{\rho} \lambda_l K_e^3 c} \frac{1}{c} \tag{2.18.2}$$

$$\alpha_e = \frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e} \tag{2.18.3}$$

Calculated Value: 7.2974E-3
Difference from CODATA: 0.000%
Calculated Units: None (*dimensionless)*

3. Proposed Geometry

The equations for the classical radius of the electron and the proton radius yield some clues to the structure of each of these particles. In the case of the proton, it started with a proposed model very different than today's understanding of a composite particle of three quarks. Proposed geometric structures of each of these particles are described below to match the equations found in Section 2.

3.1. Electron

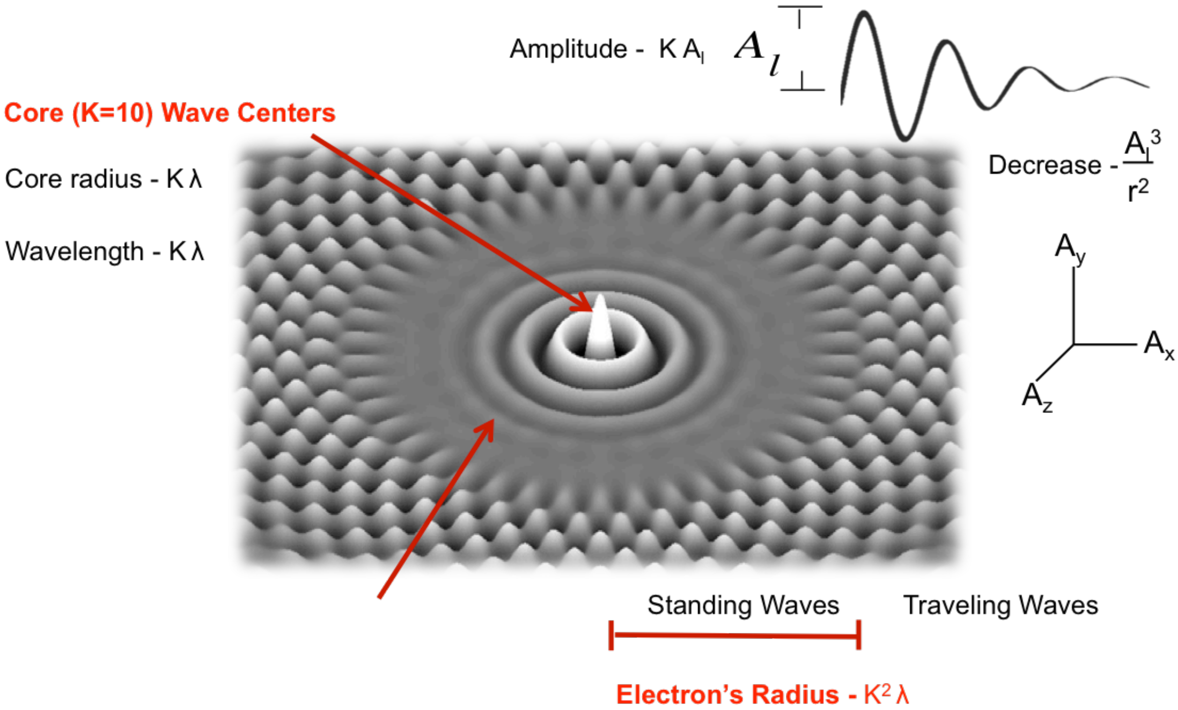
The electron is comprised of standing waves of energy. Traveling waves, throughout the universe, consist of energy with a given amplitude and wavelength. Particles, such as the electron, have wave centers that reflect these waves. Wave centers may combine, similar to how protons and neutrons form to merge an atomic nucleus. The geometric arrangements where wave centers minimize amplitude, i.e. the node of a wave, in combination leads to stable particles like the electron.

The electron's wave centers reflect in-waves of energy, and the reflected out-waves combine with the in-waves to create standing waves. These standing waves cannot maintain their standing form for infinity, so they eventually convert to become traveling waves. Standing waves of energy are potential energy, or the mass of the particle. Mass is based on the number of standing waves and the amplitude of the wave, and the particle is defined by its radius where standing waves become traveling waves.

According to the wave equations the electron has a total of 10 wave centers. It is not the fundamental particle and is therefore a composite particle of 10 individual wave centers. In the *Particle Energy and Interaction* paper, it was shown that a particle with one wave center is nearly the measured mass of the neutrino, which is a more suitable candidate for being the fundamental particle given its size and mass.

Although the equations don't support a clear view of the exact geometry of the electron, the proposed structure is a 3-level tetrahedron given that nearly all of the wave centers would be placed on the node of the wave and their amplitude is minimized. The wave centers that are slightly off the node would attempt to move to the node, potentially introducing spin to the particle. Again, this part is speculative and not supported by the equations, but would match the theory rules of wave center mechanics.

The key features of the electron that are supported by the wave theory equations are:



** Diagram is a generic particle – above is not actual 10 wavelengths (electron)*

Fig 3.1.1 – Electron Proposed Model

Notes:

- The electron is a combination of 10 particle wave centers (K) which causes a change in amplitude and wavelength proportional to the number of wave centers, i.e. amplitude (A) becomes K * A, and wavelength (λ) becomes K * λ.
- The electron mass, like other particles derived with the Longitudinal Energy Equation, is standing waves of energy until the edge (radius of the electron) at $K^2 * \lambda$. At this point, standing waves convert to traveling waves.
- The particle core has a radius of K * λ and a diameter of 2 K * λ, which is responsible for a phase shift.
- There are 10 wavelengths of standing wave energy in the electron, yet the core has nearly 50% of the electron's energy.
- The electron is formed from spherical, longitudinal waves, which there are three dimensions of an in-wave and out-wave each. In other words, an amplitude of A_x, A_y, A_z inwards (the in-wave) and likewise, the reflected wave of A_x, A_y, A_z outwards (the out-wave). These can also be represented as $A_{x\text{-in}}$, $A_{y\text{-in}}$, $A_{z\text{-in}}$, and $A_{x\text{-out}}$, $A_{y\text{-out}}$, $A_{z\text{-out}}$, for greater clarity, although it is typically listed simply as A_l^6 in most of the equations for readability as the values for amplitude are typically equal unless a particle interaction is considered.
- Amplitude decreases with the square of the distance from the particle (r^2) for the out-wave, also expressed as A_l^3 / r^2.

In 2008, scientists at Lund University in Sweden captured a video of the electron, very much resembling the standing wave structure suggested in this paper.[7] The electron wavelength counts in Fig. 3.1.2 matches the expected value of standing waves from the Longitudinal Energy Equation. It is a 10 wavelength radius from the particle core, otherwise referred to in earlier equations as K=10.

Fig. 3.1.2 shows a still image of an electron captured on video. On the left is the original picture; on the right is an attempt to measure wavelengths of the standing waves. At the edge of the particle, standing waves break down to traveling waves. The original video is available at: https://www.youtube.com/watch?v=zKwcWZ1z6J0.

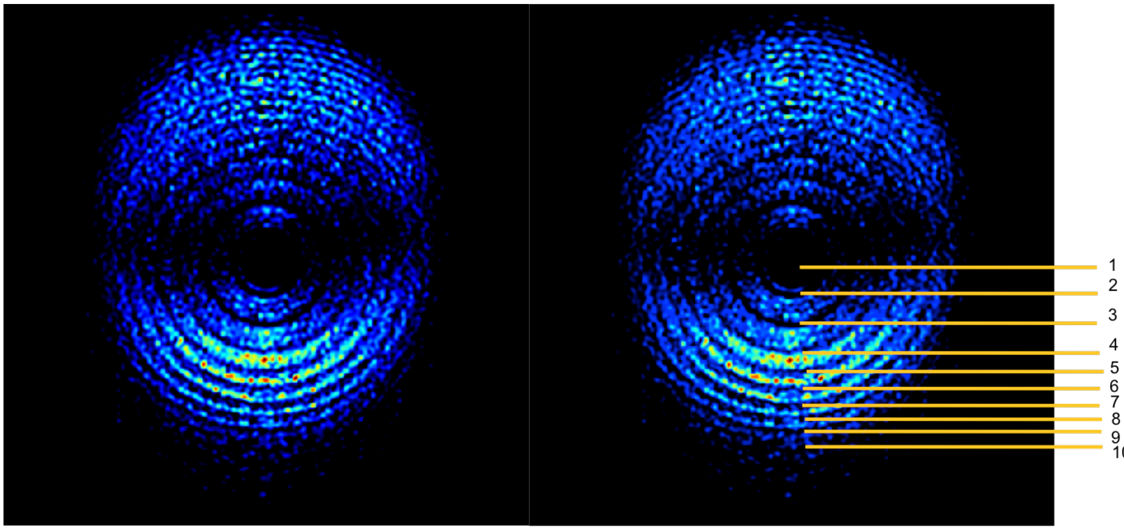


Fig 3.1.2 –Electron as Captured by Lund University (*wavelengths counted on image on right*)

3.2. Proton

The proton's radius was calculated in Section 2.3 based on a tetrahedral structure with a base of five electron wavelengths ($5K\lambda$). Since the proton is known to be a composite particle, it needed to be modeled as a combination of particles, each with their own wave center count like the electron. The energy of quarks can be represented by the Longitudinal Energy Equation to solve for the value of K, their particle wave center count. The up quark is K=14 (14 wave centers) and the down quark is K=15 (15 wave centers) using the equation.

However, it is also known that much of the energy in the proton is in its gluons, so an assumption was made that a stable particle less than 14 wave centers was responsible for the construction of the proton. The electron was selected in this proposed model in a simple three-dimensional geometric arrangement. Although electrons repel other electrons via the electromagnetic force, in the *Forces* paper, the strong force is described as creating a new core particle and a strong bond by electrons separated by one electron wavelength. The proton was thus modeled as electrons in close proximity, forming a tetrahedron shape, with a positron in the center of the structure. The anti-proton would the opposite, with four positrons at the vertices of the tetrahedron and an electron in its center.

Using this proposed geometric arrangement, the radius to the circumsphere of the new particle was calculated. The model is shown in Fig. 3.2.1 below.

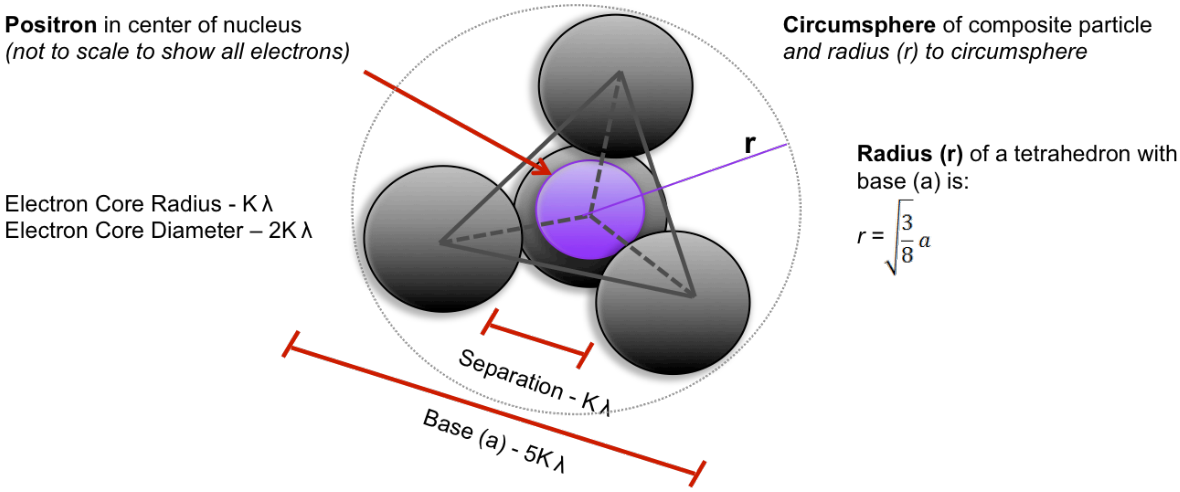


Fig 3.2.1 – Proton Proposed Model

Notes:

- The core of the proton is four electrons at the vertices of a tetrahedron
- Prior to the capture of a positron in the center, the composite particle would have constructive wave addition of K=40 (4 * K for each electron where K=10). This creates a new core with significantly more amplitude and energy than four single electrons.
- A separation distance between each of the four electron cores of K * λ leaves room for a positron to be captured in the center of the tetrahedral structure. According to experiments, there is also likely a neutrino captured somewhere within the structure.
- Only one electron wavelength (K * λ) separates two electron cores, creating a new structure for a particle. When combined, the electron no longer has 10 standing waves of energy. Another electron core resides one electron wavelength away, creating a composite particle with a new core. This causes a strong attraction (a unidirectional beam), otherwise known as a gluon.
- The neutron has a similar structure to the proton as a tetrahedron of four electrons at the vertices, but when another electron is in the center of the structure, it "annihilates" with the positron to be neutral. The wave centers for each of these particles still remain, but due to destructive wave interference, the combination of the electron and positron in the center causes it to be neutral. However, if the particle is disturbed, the electron in the middle may be ejected, leaving the positron, causing it to become a proton.

Quarks

A new proposed model of the proton must match experimental evidence, including the quark and gluon nature of the proton. In particle collisions with the proton, experiments demonstrate that the proton consists of three quarks (two up quarks and one down quark). In fact, some higher energy experiments have shown that the proton may consist of four or five quarks. In the latter experiment, when five quarks were discovered, evidence shows that the proton consists of four quarks and one anti-quark (otherwise referred to as a pentaquark).[8]

First, the standard experiment needs to be explained to match the findings where three quarks are discovered within the proton structure. In the typical particle collision with the proton, three quarks are detected. Fig. 3.2.2 describes how another particle would affect the proton structure if it consists of four electrons and one positron. Upon collision, the high-energy electrons would appear as quarks (they still contain a great amount of energy from constructive wave interference). Since the positron would immediately annihilate with one of the four electrons, it would not be detected. The wave centers of the fourth electron and positron remain, but destructive waves reduce its amplitude to near zero, and as such, it has no charge that can be detected by electromagnetic apparatus. Thus, only three of the high-energy electrons would be detected. Further, it's possible that the effect of the fourth electron and positron on one of the remaining three electrons could cause slight constructive wave interference so that it appears to have slightly more energy (down quark) than the other two electrons (up quarks).

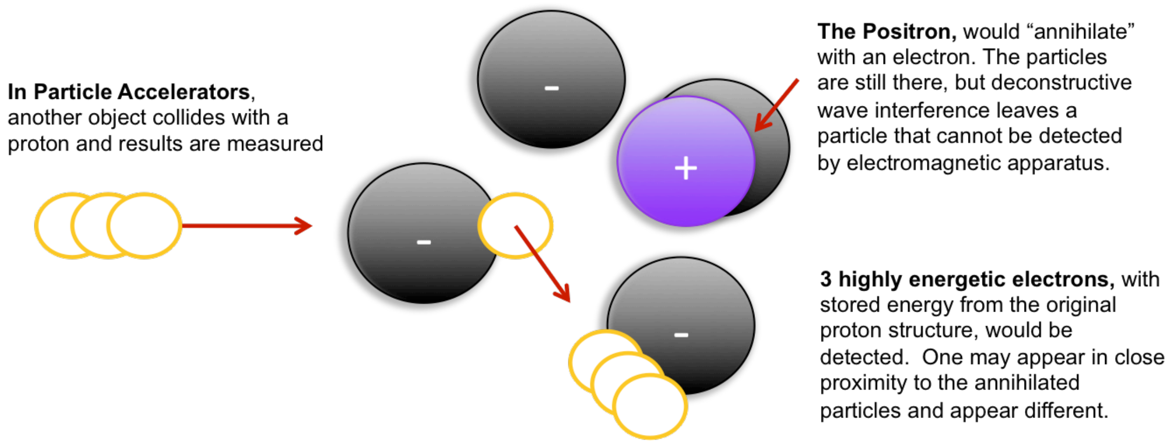


Fig 3.2.2 – Proton Collisions

This proposed model also fits the higher energy experiments that recently show four quarks and an anti-quark. Reviewing Fig 3.2.2 again, each of the electrons would be the four quarks and the positron would be the anti-quark discovered in the experiment.

Quarks are never found in isolation. They are only found within structure of the proton. Given the representation of energy as wave amplitude, it is very possible that the proton consists of electrons, which appear in very different form when in close proximity, constructively adding wave amplitude and forming the core of a new particle.

Spin & Color

The explanation of color and the proton's spin must also match experiments in the proposed structure of the proton. First, spin can be explained in Fig 3.2.3. The four electrons in the vertices of the tetrahedron might have spin that adds to zero. The positron would have spin +½ or -½, giving the proton its spin.

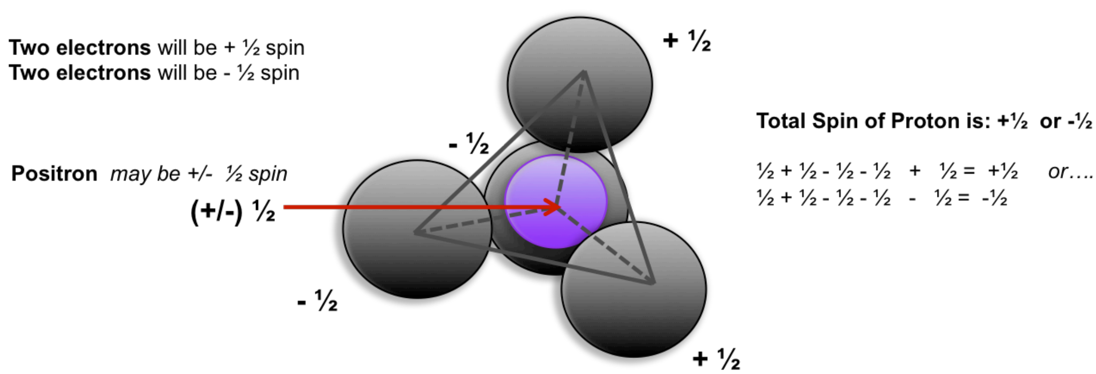


Fig 3.2.3 – Proton Spin

Spin is possibly the reason for determining the color of quarks, or the gluons that connect each of the quarks together. The model for color was based on the current understanding of a proton's three-quark arrangement.

There are three colors: Red, Green and Blue. Quarks don't really have color, but this model was developed to simplify the understanding of the quark arrangement.

When three quarks are detected, as suggested in Fig. 3.2.2, there would be three electrons with spin and one undetected electron-positron combination that may affect one of the electrons, causing it to be the down quark in the arrangement.

Thus, the following would be the possible combinations of the gluon arrangements in Fig 3.2.3 (giving each a color name to map to the known colors):

- **Red:** Two electrons of same spin (+½ and +½; or -½ and -½)
- **Green:** Two electrons of opposite spin (+½ and -½)
- **Blue:** One electron and the combination of the electron affected by the annihilated electron-positron (+½ and -½ + -½ + ½; or -½ and +½ + -½ + ½)

4. Conclusion

Eighteen of the common fundamental physical constants were derived and calculated using wave equations in this paper. Although some of these constants required modifiers, of which there are only two modifiers, most of the calculations using the wave equations do not require the use of a modifier. The exception is the Transverse Wavelength Equation used to calculate transverse wavelengths that uses the same modifier to obtain accurate wavelength calculations. The modifiers were necessary to map these equations to the known fundamental physical constants today, but these physical constants are not needed in energy and force calculations when the wave equations are used.

Deriving and explaining many of these constants should be sufficient proof of a universe explained by wave energy. The difficult gravitational constant (G) was not only calculated, but the same Force Equation from which it was derived also applies to electromagnetism and the strong force - unifying these forces together as one. In addition, the same wave equations and constants used to calculate these fundamental physical constants were found to calculate particle mass, photon energy, photon wavelengths and atomic orbitals. These are found in *Particle Energy and Interactions* and *Forces* papers.

Some of the fundamental physical constants such as Coulomb's constant (k) and the gravitational constant (G) are representations of non-variable components in the force equations, now represented by wave constants. They are no longer needed in equations when using the wave equations. Other physical constants such as the Planck mass and the fine structure constant have significant meaning, and although they can be derived using wave constants, they warrant further review to understand their meaning and their implications in the universe.

Appendix

Fine Structure Constant

The fine structure constant is found in many of the interaction equations for energy and forces. Perhaps the best explanation of the constant is that it is found when potential energy converts to kinetic energy and vice versa. It was found in the *Particle Energy and Interaction* paper as the ratio of volumes between the spherical particle (mass or stored energy) and the cylindrical photon (kinetic energy). The relationship to the fine structure constant and the volume ratio is shown in Eq. A.1.

$$\alpha_e = 2\sqrt{\frac{4}{3K_e^5}} \qquad \textbf{(A.1)}$$

Calculated Value: 0.00730

When the fine structure constant was derived in Section 2.18, it was found to be related to mass. The derived value is shown again in Eq. A.2, and then compared as a ratio to the electron's mass, derived in Section 2.1.

$$\alpha_e = \frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e} \qquad \textbf{(A.2)}$$

$$\frac{m_e}{\alpha_e} = \frac{\dfrac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 O_e}{3\lambda_l^3}}{\dfrac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e}} \qquad \textbf{(A.3)}$$

$$\frac{m_e}{\alpha_e} = \frac{4\boldsymbol{\rho} K_e \delta_e}{3} \qquad \textbf{(A.4)}$$

As seen above in Eq. A.4, mass and the fine structure constant are very related. It is seen again related to mass in the following equation.

$$\sqrt{\alpha_e} = \frac{(K_e \lambda_l)^2}{m_e} \Delta_{Ge} \qquad \textbf{(A.5)}$$

Calculated Value: 0.00734

In fact the equation above can be rewritten to be similar to the reduction of amplitude with the square of the radius, but instead it is a reduction of mass (stored energy) reduced by the square of distance of each electron wavelength (in this case measured by electron wavelengths).

$$r_{e'wavelength} = K_e \lambda_l \qquad \textbf{(A.6)}$$

$$\frac{1}{\sqrt{\alpha_e}} = \frac{m_e}{(r_{e'wavelength})^2} \Delta_{Ge} \qquad \textbf{(A.7)}$$

The similarities with the fine structure constant with potential and stored energy resemble equations for wave resonance. Resonance is described as a force that drives a system to oscillate with greater amplitude at a specific, preferential frequency. In the wave equations, the fine structure constant appears in the strong force and again in orbitals for electrons. In each case, they are positions where the electron is stable. In the strong force, the electrons are modeled at one electron wavelength from each other in the proton (See Section 3.2). In atomic orbitals, they are modeled as wavelength counts from the proton's core where the electron is stable.

As the fine structure equations resemble resonance equations, it's proposed that the fine structure constant is the fundamental frequency for the electron. The first location of the electron is found in the strong force at one electron wavelength. The remaining locations of the electron are then found as squares of the fine structure constant as it was found in the Orbital Equation in the *Particle Energy and Interaction* paper, shown again in Eq. A.7. This is the equation to calculate the atomic orbitals of the hydrogen atom where n is the shell measured in wavelengths, and N is the traditional orbital number in integers (1, 2, 3, etc).

$$n_N = K_e \left(\frac{N}{\alpha_e} \right)^2 \qquad \textbf{(A.8)}$$

If the fine structure constant is resonance, then this fundamental frequency may ultimately be derived into other resonance equations found in electronics, springs and others and provide an explanation of why they occur at the particle and atomic level.

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References

[1] "Particle Energy and Interaction: Explained and Derived by Wave Equations." Vixra. http://vixra.org/author/jeff_yee

[2] "Forces: Explained and Derived by Wave Equations." Vixra. http://vixra.org/author/jeff_yee

[3] "The Shrinking Proton: Particle is Smaller Than Thought". Live Science. http://www.livescience.com/26563-shrinking-proton-smaller-measurement.html

[4] "CODATA Recommended Values of the Fundamental Physical Constants 2014." Arxiv. http://arxiv.org/pdf/1507.07956.pdf

[5] "Proton." Wikipedia. https://en.wikipedia.org/wiki/Proton

[6] "Planck Mass." Wikipedia. https://en.wikipedia.org/wiki/Planck_mass

[7] "Electron Gets Film Debut in First Ever Video." Science Daily. http://www.sciencedaily.com/releases/2008/02/080222095358.htm

[8] "CERN's LHCb experiment reports observation of exotic pentaquark particle." CERN. http://press.cern/press-releases/2015/07/cerns-lhcb-experiment-reports-observation-exotic-pentaquark-particles