

# Fundamental Physical Constants: Explained and Derived by Energy 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 23 different constants used in physics today, including the aforementioned Planck's constant, Coulomb's constant and gravitational constant, using a proposed wave equation format. They can be derived from four universal wave constants and one variable that is constant for the electron – for a total of five constants. The universal constants are: wavelength, wave amplitude, wave speed and density. All of the fundamental physical constants that are presented in this paper can be derived from one of the four universal constants or the electron wave center constant.

In wave equation format, the property of particle charge is expressed as wave amplitude, measured as a distance instead of charge (Coulombs). When changing the Planck charge ( $q_p$ ) and elementary charge ( $e_e$ ) to an SI unit of meters, existing classical forms of the fundamental physical constants can be reduced to be derived from ten constants. This simplification also leads to more insight into the true meaning of the fundamental constants and is therefore shown in this paper. However, the correct expression is believed to be the wave equation format, as it not only further reduces the derivation of these constants to five total constants (excluding  $g$ -factors), but it is shown to calculate additional particle energies and forces found in the *Particle Energy and Interaction*<sup>1</sup>, *Forces*<sup>2</sup> and *Atomic Orbitals*<sup>3</sup> papers. It would also explain why charge should be measured as meters – a measurement of wave amplitude.

With the exception of three fundamental physical constants, all of the derived constant values are accurate to better than 0.000% of the difference from their currently accepted values, using recent CODATA values, and the values calculated in this paper.<sup>4</sup> Only the radius of the proton exceeds an accuracy difference of 0.006%, however, the proton's exact radius is subject to debate.<sup>5</sup>

Twenty-three common fundamental physical constants were solved in this paper. The method was scientific, starting with energy wave equations to model particle energies and forces. Many of today's physical constants appeared when modeling energies and forces using these energy wave equations. All 23 of these physical constants are documented as further proof that the energy wave equations are accurate and have the ability to calculate many of the characteristics of subatomic particles and their interactions with other particles.

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# 1. Fundamental Physical Constants & Energy Wave Constants

Twenty-three fundamental physical constants known commonly throughout physics are derived and explained by four wave constants and a variable constant to the electron – 20 are accurate to 0.000%. This section details the new constants and compares the current values (CODATA 2014) against calculations from this paper.

Physical Constant	CODATA Value	Calculated	% Diff	G-Factor
Fine Structure Constant	7.2974E-03	7.2974E-03	0.000%	
Electron Rest Energy	8.1871E-14	8.1871E-14	0.000%	
Electron Mass	9.1094E-31	9.1094E-31	0.000%	
Electron Classical Radius	2.8179E-15	2.8179E-15	0.000%	$g_\lambda$
Proton Mass	1.6276E-27	1.6276E-27	0.000%	$g_p^{-1}$
Proton Radius	8.7516E-16	8.6833E-16	0.780%	
Bohr Radius	5.2918E-11	5.2918E-11	0.000%	$g_\lambda$
Electron Compton Wavelength	2.4263E-12	2.4263E-12	0.000%	$g_\lambda$
Rydberg Unit of Energy	2.1799E-18	2.1799E-18	0.000%	
Rydberg Constant	1.0974E+07	1.0974E+07	0.000%	$g_\lambda^{-1}$
Planck Constant	6.6261E-34	6.6261E-34	0.000%	$g_\lambda$
Planck Time	5.3912E-44	5.3912E-44	0.000%	$g_\lambda^3$
Planck Length	1.6162E-35	1.6162E-35	0.000%	$g_\lambda^3$
Planck Mass	2.1765E-08	2.1765E-08	0.000%	$g_\lambda^{-2}$
Planck Charge	1.8755E-18	1.8755E-18	0.000%	$g_A^{-1}$
Elementary Charge	1.6022E-19	1.6022E-19	0.000%	$g_A^{-1}$
Coulomb Constant	8.9876E+09	8.9876E+09	0.000%	$g_\lambda g_A^2$
Electric Constant	8.8542E-12	8.8542E-12	0.000%	$g_\lambda^{-1} g_A^{-2}$
Magnetic Constant	1.2566E-06	1.2566E-06	0.000%	$g_\lambda g_A^2$
Bohr Magneton	9.2740E-24	9.2740E-24	0.000%	$g_\lambda g_A^{-1}$
Gravitational Constant	6.6741E-11	6.6740E-11	0.001%	$g_\lambda^5$
Avogadro Constant	6.0221E+23	6.0225E+23	-0.006%	$g_\lambda^{-2}$
Proton-Electron Mass Ratio	1836.153	1836.153	0.000%	$g_p^{-1}$

Table 1.1 – Fundamental Physical Constants (Values)

Table 1.1 includes a column for the g-factor that was used, if needed. They appear in equations requiring orbital and spin for the electron, and one for the proton, similar to the g-factors that are used as correction factors in modern physics. This is explained in Section 1.1.

Table 1.2 includes the SI units that are derived for each fundamental physical constant. Coulomb charge (C) is replaced by amplitude (meters), as charge is based on constructive and destructive wave amplitude in wave theory. When the unit of Henry (H) is derived in SI units with charge as meters, H resolves to be a mass (kilograms).

Physical Constant	CODATA SI Units	Calculated Units	Notes
Fine Structure Constant	dimensionless	dimensionless	
Electron Rest Energy	$\text{kg m}^2/\text{s}^2$	$\text{kg m}^2/\text{s}^2$	
Electron Mass	kg	kg	
Electron Classical Radius	m	m	
Proton Mass	kg	kg	
Proton Radius	m	m	
Bohr Radius	m	m	
Electron Compton Wavelength	m	m	
Rydberg Unit of Energy	$\text{kg m}^2/\text{s}^2$	$\text{kg m}^2/\text{s}^2$	
Rydberg Constant	$\text{m}^{-1}$	$\text{m}^{-1}$	
Planck Constant	$\text{kg m}^2 / \text{s}$	$\text{kg m}^2 / \text{s}$	
Planck Time	s	s	
Planck Length	m	m	
Planck Mass	kg	kg	
Planck Charge	C	m	C is amplitude (m)
Elementary Charge	C	m	C is amplitude (m)
Coulomb Constant	$\text{kg m}^3 / \text{s}^2 \text{C}^2$	$\text{kg m} / \text{s}^2$	C is amplitude (m)
Electric Constant	$\text{s}^2 \text{C}^2 / \text{kg m}^3$	$\text{s}^2 / \text{kg m}$	C is amplitude (m)
Magnetic Constant	H / m	kg / m	H is mass (kg)
Bohr Magneton	$\text{m}^2 \text{C} / \text{s}$	$\text{m}^3 / \text{s}$	C is amplitude (m)
Gravitational Constant	$\text{m}^3 / \text{s}^2 \text{kg}$	$\text{m}^3 / \text{s}^2 \text{kg}$	
Avogadro Constant	$\text{mol}^{-1}$	dimensionless	mol is a count (#)
Proton-Electron Mass Ratio	dimensionless	dimensionless	

Table 1.2 – Fundamental Physical Constants (Units)

Table 1.3 contains a summary of the derivations of each fundamental physical constant. The derivations use symbols and notation that are described in Section 1.1. It is expressed in both **classical formats** used in modern physics and a **new form expressed as wave constants**. Details outlining the steps to derive each fundamental physical constant in wave constants is found in Sections 2.1 to 2.19.

Physical Constant	Classical Format	Wave Equation Format
Fine Structure Constant	$\alpha_e = \frac{e_e^2}{q_p^2}$	$\alpha_e = \frac{3\pi\lambda_l}{K_e^5 A_l}$
Electron Rest Energy	$E_e = \frac{\mu_0 e_e^2 c^2}{4\pi r_e}$	$E_e = \frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3}$
Electron Mass	$m_e = \frac{\mu_0 e_e^2}{4\pi r_e}$	$m_e = \frac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3}$
Electron Classical Radius	$r_e = a_e^2 a_0$	$r_e = K_e^2 \lambda_l g_\lambda$
Proton Mass	N/A	$m_p = \frac{8\pi\rho K_e^7 A_l^6 O_e}{3\lambda_l^3} \sqrt{\frac{\lambda_l}{A_l}} g_p^{-1}$
Proton Radius	N/A	$r_p = \sqrt{\frac{3}{8}} \cdot 5 K_e \lambda_l$
Bohr Radius	$a_0 = \frac{r_e}{\alpha_e^2}$	$a_0 = \frac{1}{\lambda_l} \left( \frac{K_e^6 A_l}{3\pi} \right)^2 g_\lambda$
Electron Compton Wavelength	$\lambda_C = \frac{2\pi r_e}{\alpha_e}$	$\lambda_C = \frac{2K_e^7 A_l}{3} g_\lambda$
Rydberg Unit of Energy	$R_y = \frac{\mu_0 e_e^2 c^2}{8\pi a_0}$	$R_y = \frac{6\pi^3 \rho A_l^4 c^2 O_e}{K_e^5 \lambda_l}$
Rydberg Constant	$R_\infty = \frac{\alpha_e}{4\pi a_0}$	$R_\infty = \frac{27\pi^2 \lambda_l^2}{4K_e^{17} A_l^3} g_\lambda^{-1}$
Planck Constant	$h = \frac{\mu_0 q_p^2 c}{2}$	$h = \frac{8\pi\rho K_e^{12} A_l^7 c O_e}{9\lambda_l^3} g_\lambda$

Planck Time	$t_P = \frac{r_e}{c} \sqrt{\frac{\alpha_{Ge}}{\alpha_e}}$	$t_P = \frac{1}{3\pi} \sqrt{\frac{1}{2}} \cdot \frac{1}{c} \left( \frac{\lambda_l^2}{K_e^{19} A_l} \right) g_\lambda^3$
Planck Length	$l_P = r_e \sqrt{\frac{\alpha_{Ge}}{\alpha_e}}$	$l_P = \frac{1}{3\pi} \sqrt{\frac{1}{2}} \cdot \left( \frac{\lambda_l^2}{K_e^{19} A_l} \right) g_\lambda^3$
Planck Mass	$m_P = \frac{\mu_0 q_P^2}{4\pi l_P}$	$m_P = \sqrt{2} \cdot \frac{4\pi \rho K_e^{31} A_l^8 O_e}{3\lambda_l^5} g_\lambda^{-2}$
Planck Charge	$q_P = \frac{e_e}{\sqrt{\alpha_e}}$	$q_P = \frac{K_e A_l}{2} g_A^{-1}$
Elementary Charge	$e_e = q_P \sqrt{\alpha_e}$	$e_e = \sqrt{\frac{3\pi \lambda_l A_l}{4K_e^3}} g_A^{-1}$
Coulomb Constant	$k_e = \frac{\mu_0 c^2}{4\pi}$	$k_e = \frac{16\rho K_e^{10} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2$
Electric Constant	$\epsilon_0 = \frac{1}{\mu_0 c^2}$	$\epsilon_0 = \frac{9\lambda_l^3}{64\pi \rho K_e^{10} A_l^5 c^2 O_e} g_\lambda^{-1} g_A^{-2}$
Magnetic Constant	$\mu_0 = \frac{1}{\epsilon_0 c^2}$	$\mu_0 = \frac{64\pi \rho K_e^{10} A_l^5 O_e}{9\lambda_l^3} g_\lambda g_A^2$
Bohr Magneton	$\mu_B = \frac{l_P q_P c}{2} \sqrt{\frac{1}{\alpha_{Ge}}}$	$\mu_B = \frac{c}{4} \sqrt{\frac{K_e^{11} A_l^3 \lambda_l}{3\pi}} g_\lambda g_A^{-1}$
Gravitational Constant	$G = \frac{4\pi}{\mu_0} \left( \frac{l_P c}{q_P} \right)^2$	$G = \frac{\lambda_l^7 c^2}{8\pi^2 \rho K_e^{50} A_l^9 O_e} g_\lambda^5$
Avogadro Constant	$N_A = \frac{a_0}{2l_P e}$	$N_A = \frac{1}{3\pi} \sqrt{\frac{1}{2}} \cdot \frac{K_e}{e} \left( \frac{K_e^{10} A_l}{\lambda_l} \right)^3 g_\lambda^{-2}$
Proton-Electron Mass Ratio	N/A	$\frac{m_p}{m_e} = 2K_e^2 \sqrt{\frac{\lambda_l}{A_l}} g_p^{-1}$

Table 1.3 – Fundamental Physical Constants (Derivations)

## 1.1. Energy Wave Equation Constants

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

### Notation

The energy wave equations include notation to simplify variations of energies and wavelengths of different particles, in addition to differentiating longitudinal and transverse waves.

Notation	Meaning
$K_e$	Particle wave center count (e – electron)
$\lambda_l \lambda_t$	Wavelength (l – longitudinal wave, t – transverse wave)
$g, g_\lambda g_\Lambda g_p$	g-factor ( $\lambda$ – electron orbital g-factor, $\Lambda$ – electron spin g-factor, p – proton g-factor)
$F_g, F_m$	Force (g - gravitational force, m – magnetic force)
$E_{(K)}$	Energy (K – particle wave center count)

Table 1.1.1 – Energy Wave Equation Notation

### Constants and Variables

The following are the wave constants and variables used in the energy wave equations:

Symbol	Definition	Value (units)
<b>Wave Constants</b>		
$A_l$	Amplitude (longitudinal)	$3.662748116 \times 10^{-19}$ (m)
$\lambda_l$	Wavelength (longitudinal)	$2.835967539 \times 10^{-17}$ (m)
$\rho$	Density (aether)	$9.605125782 \times 10^{24}$ (kg/m <sup>3</sup> )
$c$	Wave velocity (speed of light)	299,792,458 (m/s)
<b>Variables</b>		
$\delta$	Amplitude factor	variable - <i>dimensionless</i>
$K$	Particle wave center count	variable - <i>dimensionless</i>
$Q$	Particle count in a group	variable - <i>dimensionless</i>
<b>Particle Constants</b>		
$K_e$	Electron particle count	10 - <i>dimensionless</i>



$O_e$	Electron outer shell multiplier	2.138743820 – <i>dimensionless</i>
$g_\lambda$	Electron orbital g-factor ( <i>revised</i> )	0.993643364 – <i>dimensionless</i>
$g_A$	Electron spin g-factor ( <i>revised</i> )	0.976448541 – <i>dimensionless</i>
$g_p$	Proton orbital g-factor ( <i>revised</i> )	0.958447450 – <i>dimensionless</i>

Table 1.1.2 – Energy Wave Equation Constants and Variables

**Method for calculating the values of wave constants:**

With the exception of the speed of light which is a known constant, the other three universal wave constants were set to a measured and known fundamental physical constant, noted in curly brackets  $\{\}$ . The explanations are found later in this paper in the section for each physical constant.

Wavelength (longitudinal) is set to the electron's classical radius  $\{r_e\}$ :

$$\lambda_l = \{r_e\} \frac{1}{K_e^2} g_\lambda^{-1} \quad (1.1.1)$$

After obtaining wavelength, longitudinal wave amplitude is set to the fine structure constant  $\{\alpha_e\}$ :

$$A_l = \{\alpha_e^{-1}\} \frac{3\pi\lambda_l}{K_e^5} \quad (1.1.2)$$

After obtaining wavelength and longitudinal wave amplitude, density is set to the Planck constant  $\{h\}$ :

$$\rho = \{h\} \frac{9\lambda_l^3}{8\pi K_e^{12} A_l^7 c O_e} g_\lambda^{-1} \quad (1.1.3)$$

**Method for calculating the values of electron particle count and electron outer shell multiplier:**

Particle counts were calculated in *Particle Energy and Interaction* after obtaining a linear solution for known particles. The electron particle count appears in many equations, and was given a special constant ( $K_e$ ). The particle count for the electron is 10.

$$K_e = 10 \quad (1.1.4)$$

The electron's energy and mass equations are a summation of the number of wavelengths ( $n$ ) until its radius. This value is multiplied by the energy or mass at the first core (first wavelength). It is given a special constant to reduce the need for a summation symbol in equations. It is a constant only for readability purposes.

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad (1.1.5)$$

### Method for calculating the values of the g-factors:

There are three correction factors that appear in the equations that are similar to the g-factors in physics. They have different values than the current g-factors as a result of using different constant values, but the appearance of each one is very similar.

In *Energy Wave Equations: Correction Factors*, a potential explanation for the values of these g-factors is presented as a relation of Earth's outward velocity and spin velocity against a rest frame for the universe.<sup>6</sup> This affects measurements of wavelength and amplitude of particles measured on Earth. Similar to wave constants, they are set against a fundamental physical constant as a reference. The electron orbital g-factor is set against the electron classical radius  $\{r_e\}$ , the electron spin g-factor is set against the Planck charge  $\{q_p\}$ , and the proton g-factor against the proton mass  $\{m_p\}$ . Note that Eqs. 1.1.1 and 1.1.6 are circular, and the final value was determined through iteration until all constants resolved correctly.

$$g_\lambda = \{r_e\} \frac{1}{K_e^2 \lambda_l} \quad (1.1.6)$$

$$g_A = \{q_p^{-1}\} \frac{A_l K_e}{2} \quad (1.1.7)$$

$$g_p = \{m_p^{-1}\} \frac{8\pi\rho K_e^6 A_l^6 O_e}{3\lambda_l^3} \sqrt{\frac{\lambda_l}{A_l}} \quad (1.1.8)$$

## 1.2. Classical Format Constants

This paper also derives fundamental physical constants in terms of other physical constants established in modern physics. The derivations have been reduced to ten constants, removing the need for proportionality constants like the gravitational constant (G) and the Planck constant (h). The constants used are below. Their values are the assumed to be the latest CODATA values.

- $\mu_0$  – Magnetic constant
- $\epsilon_0$  – Electric constant
- $c$  – Speed of light
- $r_e$  – Electron radius
- $a_0$  – Bohr radius
- $e_c$  – Elementary charge
- $q_p$  – Planck charge
- $l_p$  – Planck length
- $\alpha_e$  – Fine structure constant
- $\alpha_{ge}$  – Gravitational coupling constant (electron)

## 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 energy wave equations proposed herein, some of these fundamental physical constants could be derived and explained.

The complete derivations for most of these equations reside in the *Particle Energy and Interaction, Forces* or *Atomic Orbitals* papers, but in this paper, the final derivation for these physical constants will be shown in two formats: 1) classical format, and 2) a wave equation format.

The classical format is used because it contains familiar terms used in modern physics. When converting the units of charge to a unit of wave amplitude (SI unit of meters), 20 of the 23 fundamental physical constants calculated in this paper can be reduced to ten constants, removing proportionality constants like G and h.

The wave equation format is used because it is likely the true behavior of these constants appearing in energy and force equations. When using wave equation format, the constants simplify to four universal wave constants and a constant that is a property of the electron, for a total of five. G-factors are used as corrections for some of the equations (see explanation in Section 1.1), which is consistent with modern physics. The calculated value for each fundamental physical constant is the calculation using the wave equation format, which is then compared against the classical format using CODATA values.

### 2.1. Electron Energy & Mass

#### Electron Rest Energy

The electron's rest energy and mass were derived in detail in the *Particle Energy and Interaction* paper. In that paper, particle energies including the electron, were calculated as standing, longitudinal waves with wave amplitudes that decrease at distance from the particle core until reaching incoming wave amplitude, once again becoming traveling waves.

Particles consist of a variable count 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. Wave amplitude, wavelength and the particle radius where standing waves transition to traveling waves are all proportional to the number of wave centers (K).

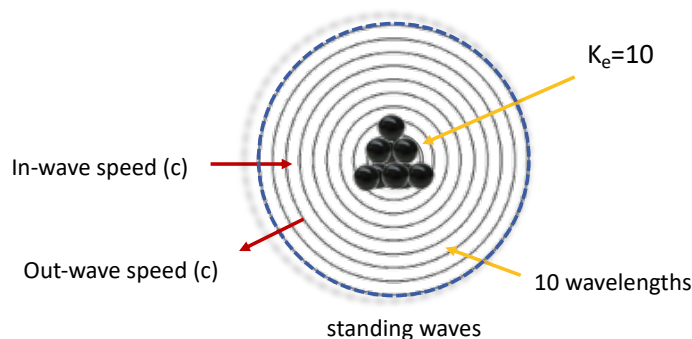


Fig 2.1.1 – Electron rest energy is standing waves of stored energy within the defined perimeter (blue dashed line)

## Classical Format

$$E_e = \frac{\mu_0 e_e^2 c^2}{4\pi r_e} \quad (2.1.1)$$

## Wave Equation Format

$$E_e = \frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} \quad (2.1.2)$$

**Calculated Value:** 8.1871E-14

**Difference from CODATA:** 0.000%

**Calculated Units:** Joules (kg m<sup>2</sup>/s<sup>2</sup>)

## Electron Rest Mass

From Fig 2.1.1, electron rest mass is energy without consideration of wave speed (without  $c^2$  in the equation of Eq. 2.1.2). Mass is simply standing, longitudinal waves of energy.

## Classical Format

$$m_e = \frac{\mu_0 e_e^2}{4\pi r_e} \quad (2.1.3)$$

## Wave Equation Format

$$m_e = \frac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3} \quad (2.1.4)$$

**Calculated Value:** 9.1094E-31

**Difference from CODATA:** 0.000%

**Calculated Units:** kg

## 2.2. Electron Radius

The electron's classical radius was derived in detail in the *Particle Energy and Interaction* paper. Particles have a defined

radius as eventually its standing waves, which defines its mass and potential energy, convert to traveling waves (radius from the core wave centers). Traveling waves still have an effect on other particles and are measured as a force, although amplitude continues to decrease proportional to distance.

The electron has 10 wave centers (K=10), affecting its wavelength, amplitude and the number of wavelengths until it becomes traveling again. Amplitude is constructive and becomes  $10 * A_1$  (amplitude) at the core; likewise, wavelength becomes  $10 * \lambda_1$  (wavelength). There is a total of 10 standing waves for the electron. When represented as a constant (K), the equation takes the form in Eq. 2.2.2. It is a distance measurement taken on Earth, moving relative to a universal reference frame, so a g-factor is used that is common across the wave equations that measure a distance from the electron's core.

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.

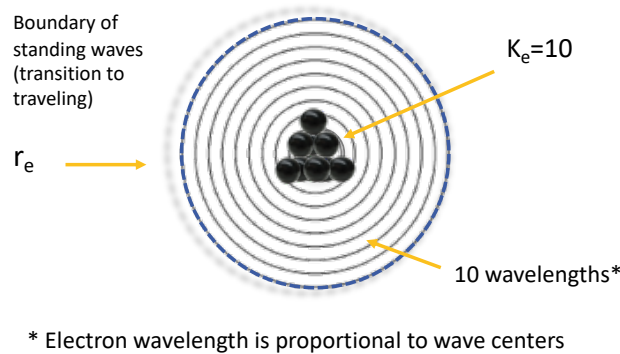


Fig 2.2.1 – Electron radius is the perimeter where standing waves transition to traveling waves

### Classical Format

$$r_e = \alpha_e^2 a_0 \quad (2.2.1)$$

### Wave Equation Format

$$r_e = K_e^2 \lambda_l g_\lambda \quad (2.2.2)$$

**Calculated Value:** 2.8179E-15

**Difference from CODATA:** 0.000%

**Calculated Units:** meters (m)

**G-Factor:**  $g_\lambda$

## 2.3. Proton Radius

The proton's radius is derived in this paper, in Section 3.2. In wave theory, the proton is modeled as a pentaquark (four particles and an antiparticle), allowing for the attractive and repelling forces used to calculate atomic orbital energies and distances in the *Atomic Orbitals* paper. 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 final derivation for the

proton's radius is found in Eq. 2.3.1.

**Classical Format**

None

**Wave Equation Format**

$$r_p = \sqrt{\frac{3}{8}} \cdot 5K_e \lambda_l \tag{2.3.1}$$

**Calculated Value:** 8.6833E-16

**Difference from CODATA:** 0.780%

**Calculated Units:** meters (m)

**Note:** No g-factor 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.<sup>7</sup>

**2.4. Bohr Radius**

The Bohr radius was derived in detail in the *Atomic Orbitals* paper. It is based on a proposed pentaquark structure of the proton, found in Section 3.2, where an alignment of particles in a proton creates a repelling force. The pentaquark structure includes four electrons and a positron at high energies resembling quarks. The positron has an attractive force (F<sub>1</sub>) on the electron. There is a repelling force (F<sub>2</sub>) when the electron is aligned on an axis with two or more “quarks”. This creates a probability function for the electron as it is only repelled when aligned at an axis. The repelling force is strong near the core, increasing in wave amplitude at the square of the inverse fine structure constant after passing through two “quarks”, but then declining at the cube of distance. This allows an orbital – a position where the attractive, Coulomb force (which declines at the square of distance) is equal to the repelling force.

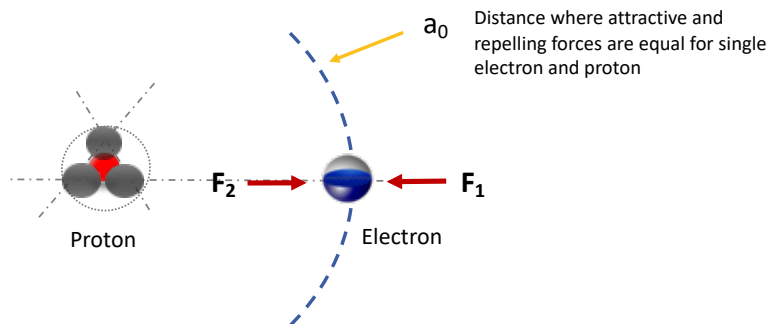


Fig 2.4.1 – Bohr radius is the distance where attractive and repelling forces are equal for a single electron and proton

## Classical Format

$$a_0 = \frac{r_e}{\alpha_e^2} \quad (2.4.1)$$

## Wave Equation Format

$$a_0 = \frac{1}{\lambda_l} \left( \frac{K_e^6 A_l}{3\pi} \right)^2 g_\lambda \quad (2.4.2)$$

**Calculated Value:** 5.2918E-11

**Difference from CODATA:** 0.000%

**Calculated Units:** meters (m)

**G-Factor:**  $g_\lambda$

## 2.5. Electron Compton Wavelength

The electron Compton wavelength was derived in detail in the *Particle Energy and Interaction* paper. It occurs when the electron and its antiparticle, the positron, annihilate. These particles are equal in energy but are placed on opposite nodes of a standing wave, such that their wave phase is opposite and create destructive wave interference when combined. After annihilation, the particles (i.e. their wave centers) still remain but they are not detectable with electromagnetic apparatus as their standing waves have collapsed. The Compton wavelength is calculated when the particles reach a distance of half the electron radius, a convenient position for the two particles to have complete destructive wave interference. The energy of the standing waves is transferred to transverse waves as the particles vibrate before coming to rest, creating two photons traveling in opposite directions.

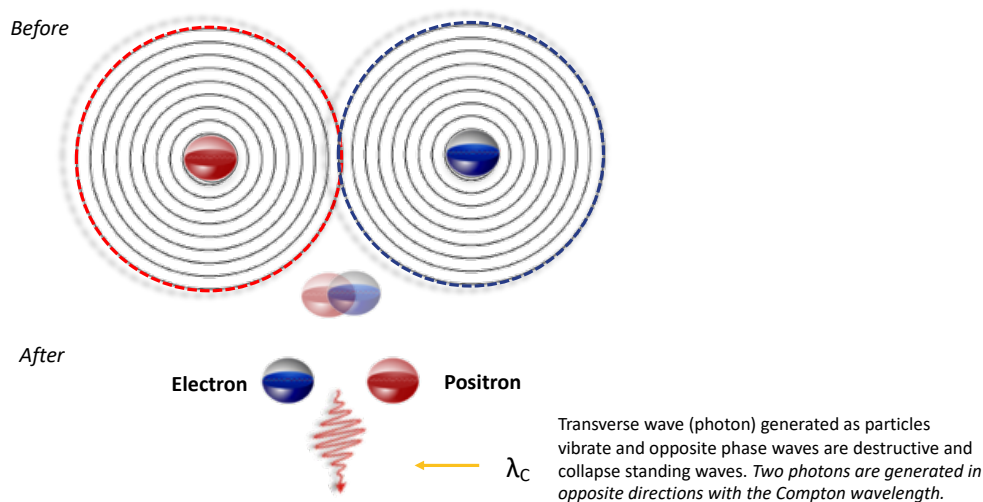


Fig 2.5.1 – Compton wavelength of photon generated as electron and positron vibrate and generate a transverse (annihilation)

## Classical Format

$$\lambda_C = \frac{2\pi r_e}{\alpha_e} \quad (2.5.1)$$

## Wave Equation Format

$$\lambda_C = \frac{2K_e^7 A_l}{3} g_\lambda \quad (2.5.2)$$

Calculated Value: 2.4263E-12

Difference from CODATA: 0.000%

Calculated Units: meters (m)

G-Factor:  $g_\lambda$

## 2.6. Rydberg Unit of Energy & Rydberg Constant

### Rydberg Unit of Energy (joules)

The Rydberg unit of energy and the Rydberg constant were derived in detail in the *Particle Energy and Interaction* paper. For a single electron and proton (ground state of hydrogen), the Rydberg unit of energy is the binding energy between the electron and proton. In Section 2.4, the Bohr radius is calculated as the position where two forces are equal. Energy is a force exerted at distance. The Rydberg unit of energy is this force exerted over a distance of the Bohr radius.

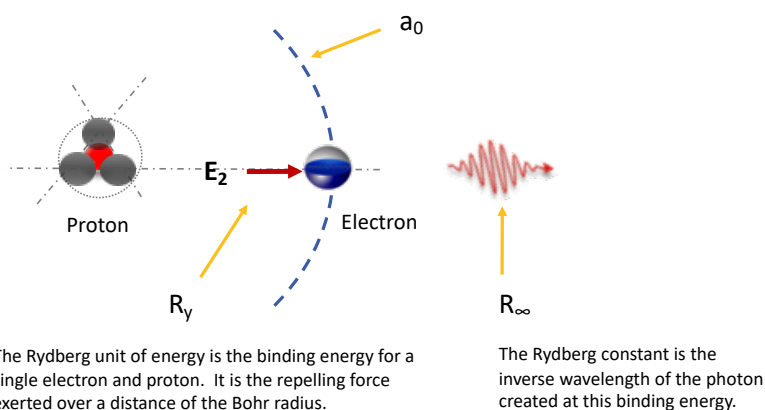


Fig 2.6.1 – Rydberg unit of energy and Rydberg constant express the binding energy of hydrogen in different terms

## Classical Format

$$R_y = \frac{\mu_0 e_e^2 c^2}{8\pi a_0} \quad (2.6.1)$$



## Wave Equation Format

$$R_y = \frac{6\pi^3 \rho A_l^4 c^2 O_e}{K_e^5 \lambda_l} \quad (2.6.2)$$

**Calculated Value:** 2.1799E-18

**Difference from CODATA:** 0.000%

**Calculated Units:** Joules (kg m<sup>2</sup>/s<sup>2</sup>)

## Rydberg Constant (meters<sup>-1</sup>)

The Rydberg constant expresses the photon that is released when the binding energy (Rydberg unit of energy) is transferred to transverse form, creating the photon. The photon is measured in frequency or wavelength. The Rydberg constant is expressed as a hybrid of both, as either frequency without wave speed (c) or as the inverse of wavelength.

## Classical Format

$$R_\infty = \frac{\alpha_e}{4\pi a_0} \quad (2.6.3)$$

## Wave Equation Format

$$R_\infty = \frac{27\pi^2 \lambda_l^2}{4K_e^{17} A_l^3} g_\lambda^{-1} \quad (2.6.4)$$

**Calculated Value:** 1.0974E+07

**Difference from CODATA:** 0.000%

**Calculated Units:** m<sup>-1</sup>

**G-Factor:** g<sub>λ</sub><sup>-1</sup>

## 2.7. Planck Constant

The Planck constant is a proportionality constant that was derived in detail in the *Particle Energy and Interaction* paper. It is a combination of other constants in an energy equation that expresses the binding energy between the atomic nucleus and an electron at distance, leaving a variable for the frequency of a photon that is generated or absorbed. In Section 2.6, the binding energy of a single electron and proton (hydrogen) is the Rydberg unit of energy. Beyond hydrogen, atoms have additional protons in the nucleus and electrons in surrounding orbitals, changing the wave

interference at a given electron being measured. It also affects the distance to its orbital where forces are equal, as shown in the *Atomic Orbitals* paper where photon energies are calculated for the first twenty elements.

Frequency (f) is the variable in the equation, but it masks two variables: one for the distance between the electron and nucleus and one for the constructive wave interference the electron experiences from surrounding particles. The Planck constant contains the remaining wave constants in the energy equation.

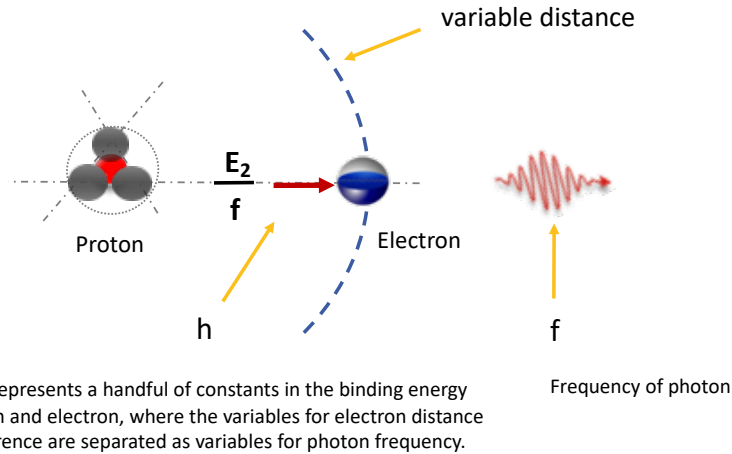


Fig 2.7.1 – Planck constant represents constants in binding energy when frequency is variable

### Classical Format

$$h = \frac{\mu_0 q_p^2 c}{2} \tag{2.7.1}$$

### Wave Equation Format

$$h = \frac{8\pi\rho K_e^{12} A_l^7 c O_e}{9\lambda_l^3} g_\lambda \tag{2.7.2}$$

**Calculated Value:** 6.6261E-34

**Difference from CODATA:** 0.000%

**Calculated Units:** kg m<sup>2</sup> / s

**G-Factor:** g<sub>λ</sub>

## 2.8. Planck Length

Planck length is derived here in this paper. It is an extremely small distance, found as a ratio of the electron’s classical radius and the square of two coupling constants for the electron: 1) the gravitational coupling constant and 2) the strong force coupling constant (the fine structure). As expressed mathematically in Eq. 2.8.1, if the relative strength of gravity was equal to the relative strength of the strong force (when compared to the electric force), the ratio would be one and Planck length would be equal to the electron’s radius. The weaker gravity is compared to the electric

force, the shorter the distance for Planck length.

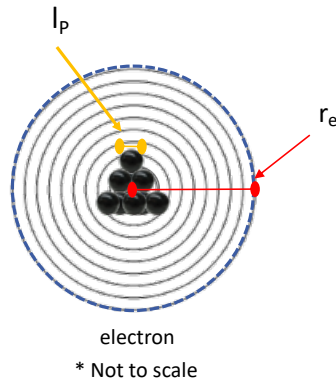


Fig 2.8.1 – Planck length is the ratio of the electron’s radius as a function of two coupling constants

Classical Format

$$l_P = r_e \sqrt{\frac{\alpha_{Ge}}{\alpha_e}} \quad (2.8.1)$$

Wave Equation Format

$$l_P = \frac{1}{3\pi} \sqrt{\frac{1}{2}} \cdot \left( \frac{\lambda_l^2}{K_e^{19} A_l} \right) g_\lambda^3 \quad (2.8.2)$$

Calculated Value: 1.6162E-35

Difference from CODATA: 0.000%

Calculated Units: m

G-Factor:  $g_\lambda^3$

## 2.9. Planck Time

Planck length is derived here in this paper. The equations in both the classical format and wave equation format of Planck time are similar to Planck length, with the exception of the constant for the speed of light (c). This is because Planck time is defined as the time that it takes for a wave traveling at the speed of light to travel the Planck length.

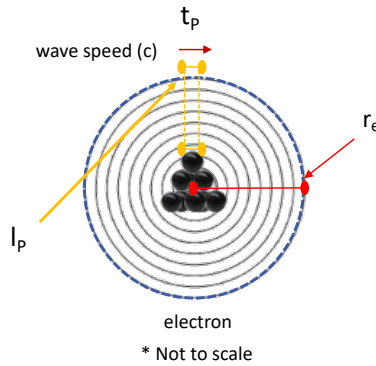


Fig 2.9.1 – Planck time is the time that it takes for a wave traveling at the speed of light to travel a distance of the Planck length

**Classical Format**

$$t_P = \frac{r_e}{c} \sqrt{\frac{\alpha_{Ge}}{\alpha_e}} \tag{2.9.1}$$

**Wave Equation Format**

$$t_P = \frac{1}{3\pi} \sqrt{\frac{1}{2} \cdot \frac{1}{c} \left( \frac{\lambda_l^2}{K_e^{19} A_l} \right)} g_\lambda^3 \tag{2.9.2}$$

**Calculated Value:** 5.3912E-44  
**Difference from CODATA:** 0.000%  
**Calculated Units:** seconds (s)  
**G-Factor:**  $g_\lambda^3$

**2.10. Planck Mass**

The Planck mass is derived here in this paper. When expressed in terms of classical terms, it is similar to the electron mass seen in Section 2.1 with the exception of two things: 1) the Planck charge ( $q_p$ ) replaces the elementary charge ( $e_e$ ), and 2) the Planck length ( $l_p$ ) replaces the electron classical radius ( $r_e$ ) – refer to Eq. 2.10.1 and compare to Eq. 2.1.3. In Fig. 2.10.1, the wave with amplitude of Planck charge is shown affecting a wave center in the electron, of Planck length. It will be described in more detail in the section on gravity (Section 2.16).

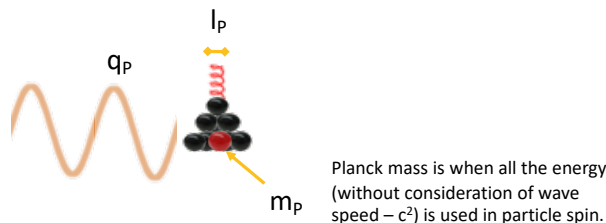


Fig 2.10.1 – Planck mass

Classical Format

$$m_P = \frac{\mu_0 q_P^2}{4\pi l_P} \tag{2.10.1}$$

Wave Equation Format

$$m_P = \sqrt{2} \cdot \frac{4\pi\rho K_e^{31} A_l^8 O_e^{-2}}{3\lambda_l^5} g_\lambda \tag{2.10.2}$$

Calculated Value: 2.1765E-08

Difference from CODATA: 0.000%

Calculated Units: kg

G-Factor:  $g_\lambda^{-2}$

## 2.11. Planck Charge

The Planck charge was derived in detail and illustrated in the *Forbes* paper. It is a measurement of wave amplitude at the first wavelength from the electron’s core, where wave centers reflect in-waves to become standing waves. At the core, ten wave centers for the electron ( $K_e=10$ ) amplify longitudinal waves proportional to the number of waves centers, becoming  $K_e A_l$  in amplitude. After leaving the core, amplitude decreases with distance, becoming half the amplitude at the first wavelength. It is the Planck charge, as expressed in Eq. 2.11.2. The g-factor for electron spin is seen for the first time in this paper as a correction for the measurement of amplitude, measured on a moving Earth against a universal reference frame (see explanation of g-factors in Section 1.1).

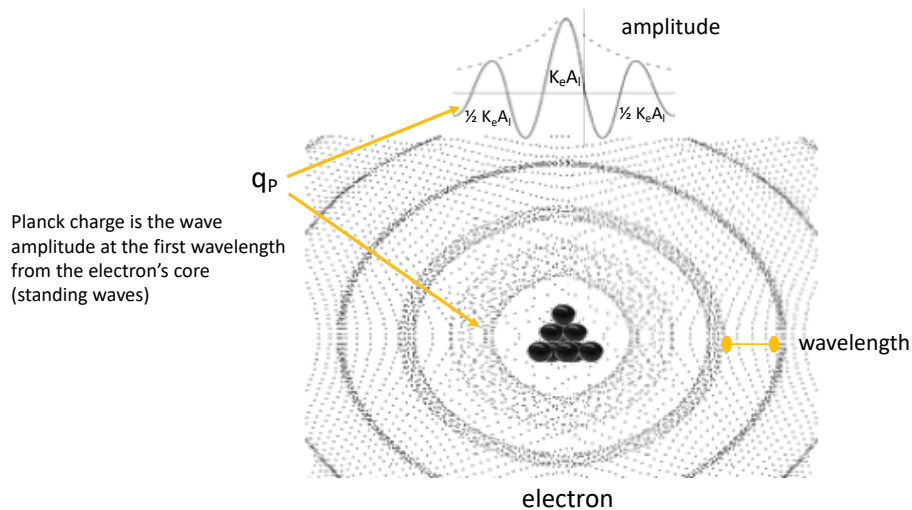


Fig 2.11.1 – Electron’s standing waves. Planck charge is the wave amplitude at the first wavelength from the electron’s core.

Classical Format

$$q_P = \frac{e_e}{\sqrt{\alpha_e}} \tag{2.11.1}$$

Wave Equation Format

$$q_P = \frac{K_e A_l^{-1}}{2} g_A \tag{2.11.2}$$

Calculated Value: 1.8755E-18

Difference from CODATA: 0.000%

Calculated Units: m

G-Factor:  $g_A^{-1}$

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

## 2.12. Elementary Charge

The elementary charge was derived in detail and illustrated in the *Forces* paper. Wave amplitude continues to decrease from the electron’s core with each wavelength, transitioning from standing waves to traveling waves at the electron’s classical radius. Traveling waves contain energy, but are no longer stored energy (particle rest energy). Traveling wave energy is experienced as a force between particles at distance. Because wave amplitude decreases at distance, it is measured relative to the elementary charge (wave amplitude at first wavelength of traveling waves) to distance. Whereas the Planck charge is the amplitude at the first standing wave wavelength, the elementary charge is the amplitude at the first traveling wave wavelength.

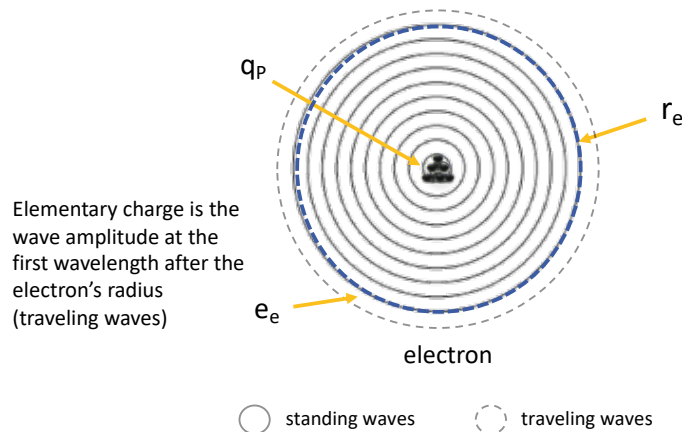


Fig 2.12.1 – Elementary charge is the wave amplitude at the first wavelength of traveling waves (beyond electron’s radius).

## Classical Format

$$e_e = q_P \sqrt{a_e} \quad (2.12.1)$$

## Wave Equation Format

$$e_e = \sqrt{\frac{3\pi\lambda_l A_l}{4K_e^3}} \cdot g_A^{-1} \quad (2.12.2)$$

**Calculated Value:** 1.6022E-19

**Difference from CODATA:** 0.000%

**Calculated Units:** m

**G-Factor:**  $g_A^{-1}$

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

## 2.13. Coulomb Constant

The Coulomb constant was derived in detail in the *Forces* paper. It is the combination of constants in a wave equation, where the remaining variables are wave amplitude and distance. In wave theory, waves travel through a medium with a universal wavelength ( $\lambda_l$ ), amplitude ( $A_l$ ) and speed ( $c$ ), responsible for creating particle energy/mass and forces. There is a universal force as a result of this motion, but only detectable when there is a change. The universal force is the Coulomb constant.

Fig. 2.13.1 illustrates wave motion in the universe. In the absence of any particles, there would still be energy as a result of this motion. The force would be Coulomb's constant, i.e.  $F=k_e$ . In the latter part of this section, the Coulomb constant is derived to be units of a force when charge (Coulombs) is replaced by wave amplitude (meters), proving that it is indeed a force.

When particles are present, wave amplitude changes as a result of wave interference between particles. Wave amplitude declines with distance, therefore the force now becomes  $F=k_e(q_1q_2/r^2)$ , where the variables are separated by parentheses. Note that the variables become a dimensionless ratio when charge is replaced with wave amplitude.

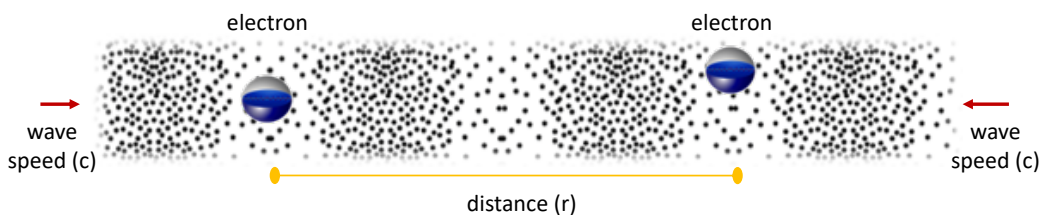


Fig 2.13.1 – Coulomb's constant represents a universal force that is affected by constructive wave interference between particles

## Classical Format

$$k_e = \frac{\mu_0 c^2}{4\pi} \quad (2.13.1)$$

## Wave Equation Format

$$k_e = \frac{16\rho K_e^{10} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2 \quad (2.13.2)$$

**Calculated Value:** 8.9876E+9

**Difference from CODATA:** 0.000%

**Calculated Units:** kg m / s<sup>2</sup>

**G-Factors:** g<sub>λ</sub>, g<sub>A</sub><sup>2</sup>

**Note:** The above units are based in kg \* m/s<sup>2</sup>. By comparison the Coulomb constant (k) is measured in N \* m<sup>2</sup>/C<sup>2</sup>. 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<sup>2</sup>, 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:

$$\frac{Nm^2}{C^2} = \frac{kg(m)}{s^2} \frac{m^2}{m^2} = \frac{kg(m)}{s^2} \quad (2.13.3)$$

## 2.14. Electric Constant (Vacuum Permittivity)

The electric constant is the inverse of 4πk<sub>e</sub> (Coulomb constant) and is derived here. Therefore, the explanation is the same as Section 2.13, although the value and units have changed as a result of being the inverse.

## Classical Format

$$\epsilon_0 = \frac{1}{\mu_0 c^2} \quad (2.14.1)$$



## Wave Equation Format

$$\epsilon_0 = \frac{9\lambda_l^3}{64\pi\rho K_e^{10} A_l^5 c^2 O_e} g_\lambda^{-1} g_A^{-2} \quad (2.14.2)$$

**Calculated Value:** 8.8542E-12

**Difference from CODATA:** 0.000%

**Calculated Units:** s<sup>2</sup> / kg m

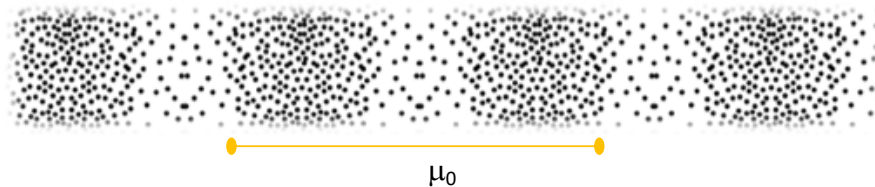
**G-Factors:** g<sub>λ</sub><sup>-1</sup>, g<sub>A</sub><sup>-2</sup>

**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 Coulomb constant and is derived here. It is 4πk<sub>e</sub> without consideration of wave speed (i.e. divide by c<sup>2</sup>). The removal of wave speed has significant meaning as it is no longer a force. The units, which are derived later in this section, resolve to be the equivalent of a one-dimensional density. The units are kilograms per meter.

Waves travel in a medium, as illustrated in Fig. 2.15.1. The magnetic constant represents the amount of “stuff” in a given length for this medium, better expressed as kilograms per meter. When this stuff is contained in a particle as standing waves, it is truly measured in kilograms. When it is traveling waves, it has been given the wrong unit and called a Henry. The Henry can be resolved to kilograms when Coulomb charge is replaced with wave amplitude.



The units of the magnetic constant resolve to be kilograms per meter (kg/m), similar to a one-dimensional density property of a substance in which waves flow

Fig 2.15.1 – The magnetic constant is a representation of the substance that allows waves to travel

## Classical Format

$$\mu_0 = \frac{1}{\epsilon_0 c^2} \quad (2.15.1)$$

## Wave Equation Format

$$\mu_0 = \frac{64\pi\rho K_e^{10} A_l^5 O_e}{9\lambda_l^3} g_\lambda g_A^2 \quad (2.15.2)$$

**Calculated Value:** 1.2566E-6  
**Difference from CODATA:** 0.000%  
**Calculated Units:** kg / m  
**G-Factors:**  $g_A, g_A^2$

**Note:** The units are measured in kg/m compared with H/m for the magnetic constant, where H is Henries. When Henries is derived in SI units to Coulombs and replaced with meters, the units resolve correctly to kg/m.

$$H\left(\frac{1}{m}\right) = \frac{kg(m^2)}{s^2(A^2)}\left(\frac{1}{m}\right) = \frac{kg(m^2)}{s^2\left(\frac{m}{s}\right)^2}\left(\frac{1}{m}\right) = \frac{kg}{m} \quad (2.15.3)$$

## 2.16. Gravitational Constant & Gravitational Coupling Constant

### Gravitational Coupling Constant (Electron)

The Gravitational constant (G) was derived in detail in the *Forces* paper after deriving the gravitational coupling constants for the electron ( $\alpha_{Ge}$ ). Thus, the coupling constant is explained first. Classically, the coupling constant is the ratio of gravitational force of two electron masses versus the electric force of two electron charges. But this doesn't describe what it truly is. In wave equation format, it is explained as a slight reduction in wave amplitude at the electron's core – the slight difference in wave amplitude between the longitudinal in-wave and longitudinal out-wave. The proposed reason for the amplitude reduction is the transfer of the energy for particle spin. This is illustrated in the next figure.

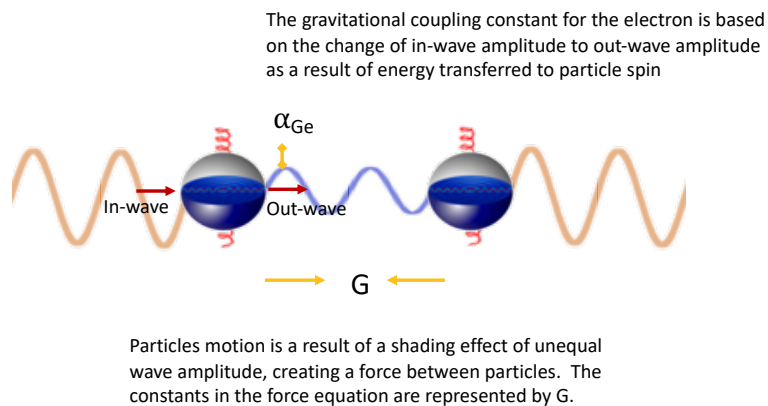


Fig 2.16.1 – The constants for gravity represent particle motion as a result of unequal wave amplitude

### Classical Format

$$\alpha_{Ge} = \frac{Gm_e^2}{k_e e^2} \quad (2.16.1)$$

## Wave Equation Format

$$\alpha_{Ge} = \frac{1}{3\pi} \frac{K_e}{2} \left( \frac{\lambda_l}{K_e^{16} A_l} \right)^3 g_\lambda^4 \quad (2.16.2)$$

**Gravitational Coupling Constant (Electron):** 2.4005E-43

**Calculated Units:** None (*dimensionless*)

## Gravitational Constant

In the *Forces* paper, the electric force is modeled with the wave amplitude reduction in Eq. 2.16.2. For two particles, the slight reduction is negligible in force measurements. For a large body of electrically neutral particles (atoms with protons and electrons that cancel), the destructive amplitude reduction begins to have noticeable effects. The wave equation that models forces naturally contains the constants that make up the complex G constant, and is shown in Eq. 2.16.4. See the *Forces* paper for the complete derivation.

## Classical Format

$$G = \frac{4\pi}{\mu_0} \left( \frac{l_P c}{q_P} \right)^2 \quad (2.16.3)$$

## Wave Equation Format

$$G = \frac{\lambda_l^7 c^2}{8\pi^2 \rho K_e^{50} A_l^9 O_e} g_\lambda^5 \quad (2.16.4)$$

**Calculated Value:** 6.6740E-11

**Difference from CODATA:** 0.001%

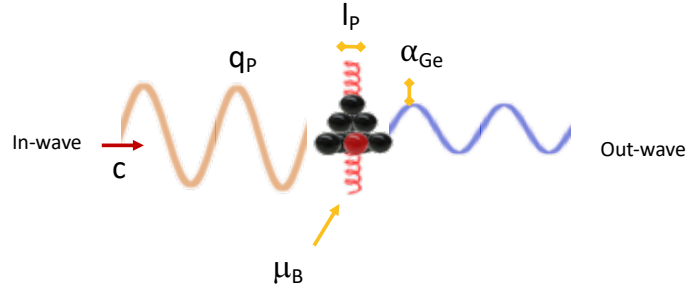
**Calculated Units:** m<sup>3</sup> / s<sup>2</sup> kg

**G-Factor:** g $\lambda^5$

## 2.17. Bohr Magnetron

The Bohr magnetron is derived in the *Forces* paper. When a wave center is not on the node of a standing wave, it causes motion until on the node. Meanwhile, other wave centers are also affected as one wave center moves to the node, causing a continual spin of the electron particle. The loss of wave amplitude in the longitudinal out-wave, which is the cause of gravity (see Section 2.16), is transferred to the new transverse wave that is created as the particle spins, for a conservation of energy. The Bohr magnetron is the flow rate of the transverse waves created by the

electron. When derived in both classical and wave equation format, it has units of meters cubed per second.



The Bohr magneton is a transverse wave, created as the electron spins. A wave center that is off node (colored red) is pushed by the wave with amplitude of Planck charge. It causes a movement of the wave center a distance Planck length. Absorbing the energy for movement, the out-wave amplitude is reduced.

Fig 2.17.1 – The Bohr magneton represents a transverse wave created as the electron spins

### Classical Format

$$\mu_B = \frac{l_p q_p c}{2} \sqrt{\frac{1}{\alpha_{Ge}}} \quad (2.17.1)$$

### Wave Equation Format

$$\mu_B = \frac{c}{4} \sqrt{\frac{K_e^{11} A_l^3 \lambda_l}{3\pi}} \cdot g_\lambda g_A^{-1} \quad (2.17.2)$$

**Calculated Value:** 9.2740E-24

**Difference from CODATA:** 0.000%

**Calculated Units:** m<sup>3</sup> / s

**G-Factors:** g<sub>λ</sub>, g<sub>A</sub><sup>-1</sup>

**Note:** The above units are based in m<sup>3</sup>/s. By comparison the Bohr Magnetron is measured in J/T (Joules per Tesla). Joules are measured in kg \* m<sup>2</sup>/s<sup>2</sup>. 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 Magnetron to the wave theory version is as follows:

$$\frac{J}{T} = \frac{\frac{kg \cdot m^2}{s^2}}{\frac{kg}{Cs}} = \frac{\frac{kg \cdot m^2}{s^2}}{\frac{kg}{(m) s}} = \frac{m^3}{s} \quad (2.17.3)$$

## 2.18. Fine Structure Constant

The fine structure constant is perhaps the most important of the constants, as it appears in the calculations of photons in the *Particle Energy and Interaction* paper, in the strong force in the *Forces paper*, and in the orbital calculations in the *Atomic Orbitals* paper. In the proposed structure of the proton in this paper, Section 3.2, it is proposed that highly energetic electrons are quarks. The energy to spin is consumed from longitudinal in-waves, and the increase in spin creates a transverse wave that is known as the gluon. The fine structure is the wave amplitude reduction ratio of the longitudinal wave; the inverse of the fine structure is the wave amplitude increase ratio of the transverse wave – responsible for the strong force. It is expressed in wave equation format (Eq. 2.18.2) as the decrease in amplitude per wavelength over  $3\pi$ . This has similarities with other coupling constants as detailed later in this section.

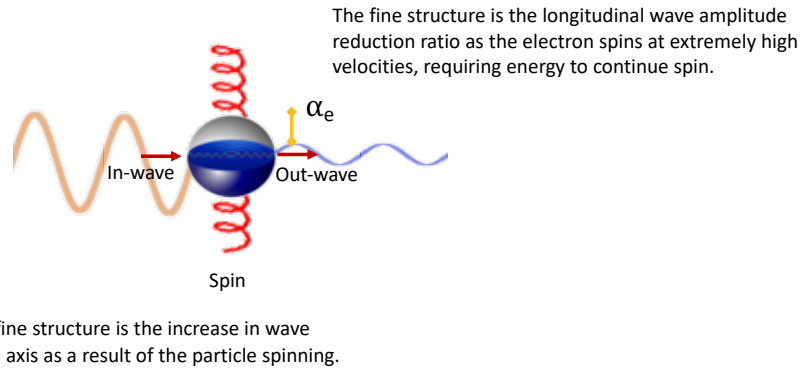


Fig 2.18.1 – The reduction in longitudinal wave amplitude and increase in transverse (spin) wave amplitude of the electron

### Classical Format

$$\alpha_e = \frac{e^2}{q_p^2} \quad (2.18.1)$$

### Wave Equation Format

$$\alpha_e = \frac{3\pi\lambda_l}{K_e^5 A_l} \quad (2.18.2)$$

**Calculated Value:** 7.2974E-3

**Difference from CODATA:** 0.000%

**Calculated Units:** None (*dimensionless*)

### Similarities of Coupling Constants

The fine structure is a coupling constant between the electric force and strong force. The gravitational coupling constant is the ratio of the electric force to gravitational force. There are similarities when comparing the gravitational

coupling constants for the electron (Section 2.17) and proton to the inverse of the fine structure constant (which is the increase from electric force to strong force). In fact, even Planck length and Planck time share this similarity as well (seen in Sections 2.8 and 2.9 respectively). All are ratios of amplitude and wavelength, and all are over  $3\pi$ .

$$\frac{1}{\alpha_e} = \frac{1}{3\pi} K_e^5 \left( \frac{A_l}{\lambda_l} \right) \quad (2.18.3)$$

Fine Structure Constant (Inverse)

$$\alpha_{Ge} = \frac{1}{3\pi} \frac{K_e}{2} \left( \frac{\lambda_l}{K_e^{16} A_l} \right)^3 g_\lambda^4 \quad (2.18.4)$$

Gravitational Coupling Constant - Electron

$$\alpha_{Gp} = \frac{1}{3\pi} 2K_e \left( \frac{\lambda_l}{K_e^{11} A_l} \right)^4 g_\lambda^4 g_p^{-2} \quad (2.18.5)$$

Gravitational Coupling Constant - Proton

## 2.19. Proton Mass

The proton mass is derived here in this paper as a result of a proposed pentaquark geometry for the proton found in Section 3.2. In Section 3.2, the proton is modeled to consist of four quarks and an antiquark, responsible for the attractive and repelling forces found in the *Atomic Orbitals* paper. Furthermore, it is proposed that quarks are highly energetic electrons and the antiquark is the positron (refer to Section 3.2 for details). The wave equation format in Eq. 2.19.1 for the proton mass supports this possibility as two constants for the electron appear in the equation ( $K_e$  and  $O_e$ ). The proton has a different g-factor that is used here, unique to the proton mass and the proton-electron mass ratio found in Section 2.21.

**Classical Format**

None

**Wave Equation Format**

$$m_p = \frac{8\pi\rho K_e^7 A_l^6 O_e}{3\lambda_l^3} \sqrt{\frac{\lambda_l}{A_l}} \cdot g_p^{-1} \quad (2.19.1)$$

**Calculated Value:** 1.6726E-27  
**Difference from CODATA:** 0.000%  
**Calculated Units:** kg  
**G-Factor:** g<sub>p</sub><sup>-1</sup>

## 2.20. Avogadro Constant

The Avogadro constant is used in photon energy calculations, but only as a conversion for comparisons against measured results provided in MJ/mol. It is found in the *Particle Energy and Interaction* and *Atomic Orbitals* papers. Here, in this paper, it is derived from a classical representation. The Avogadro constant is related to the Faraday constant (F) or the gas constant (R), but this requires explaining new constants. It can also be related to the Bohr radius (a<sub>0</sub>) and Planck length (l<sub>p</sub>) constants already derived here in this paper, which is shown in Eq. 2.20.1. Note that “e” in Eqs. 2.20.1 and 2.20.2 is the mathematical constant (e), not the elementary charge (e<sub>e</sub>).

**Classical Format**

$$N_A = \frac{a_0}{2l_p e} \quad (2.20.1)$$

**Wave Equation Format**

$$N_A = \frac{1}{3\pi} \sqrt{\frac{1}{2}} \cdot \frac{K_e}{e} \left( \frac{K_e^{10} A_l}{\lambda_l} \right)^3 g_\lambda^{-2} \quad (2.20.2)$$

**Calculated Value:** 6.0225E+23  
**Difference from CODATA:** -0.006%  
**Calculated Units:** None (*dimensionless*)  
**G-Factor:** g<sub>λ</sub><sup>-2</sup>

## 2.21. Proton-Electron Mass Ratio

The proton-electron mass ratio is derived here in this paper as a result of the masses for the electron and proton found in Sections 2.1 and 1.19 respectively. When Eq. 2.19.1 is divided by Eq. 2.14, the mass ratio is an interesting ratio of the square root of wavelength and amplitude, as expressed in the wave equation format below. The ratios of amplitude and wavelength are also found in other mass ratios found in Eqs. 2.21.2 and 2.21.3.

**Classical Format**

None

## Wave Equation Format

$$\frac{m_p}{m_e} = 2K_e^2 \sqrt{\frac{\lambda_l}{A_l}} \cdot g_p^{-1} \quad (2.21.1)$$

### Proton – Electron Mass Ratio

**Calculated Value:** 1836.153

**Difference from CODATA:** 0.000%

**Calculated Units:** None (*dimensionless*)

## Similarities of Mass Ratios

The proton-electron mass ratio shares similarities with the mass ratios for the Planck mass-electron and Planck mass-to proton ratios, as ratio of amplitude to wavelength. They are as follows:

$$\frac{m_P}{m_e} = \sqrt{2} \cdot K_e^{26} \sqrt{\frac{A_l^4}{\lambda_l^4}} \cdot g_\lambda^{-2} \quad (2.21.2)$$

### Planck Mass – Electron Mass Ratio

$$\frac{m_P}{m_p} = \frac{1}{\sqrt{2}} K_e^{24} \sqrt{\frac{A_l^5}{\lambda_l^5}} \cdot g_\lambda^{-2} g_p \quad (2.21.3)$$

### Planck Mass – Proton Mass Ratio



## 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 from 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

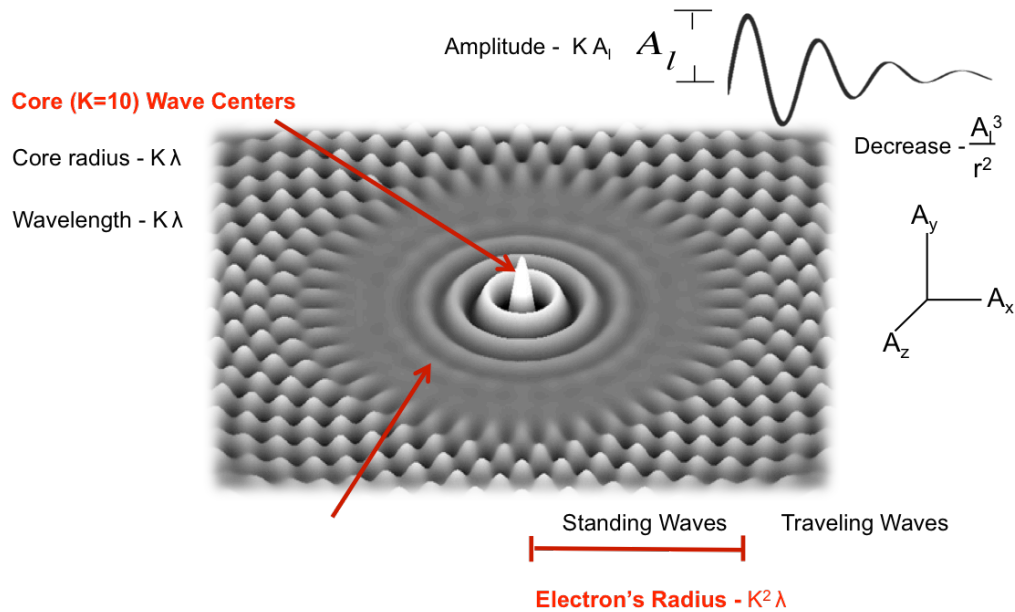
The electron is comprised of standing waves of energy. Traveling waves, throughout the universe, consist of energy with a given amplitude and wavelength. Particles, such as the electron, have wave centers that reflect these waves. Wave centers may combine, similar to how protons and neutrons form to 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 once wave amplitude declines at distance to be less than incoming wave amplitude. 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 energy 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.

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 ( $\lambda$ ) becomes  $K * \lambda$ .
- 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  $K * \lambda$  and a diameter of  $2 K * \lambda$ , 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  $A_{x-in}, A_{y-in}, A_{z-in}$ , and  $A_{x-out}, A_{y-out}, A_{z-out}$ , for greater clarity, although it is typically listed simply as  $A_1^6$  in most of the equations for readability as the values for amplitude are typically equal unless a particle interaction is considered.
- Amplitude decreases with distance (r) from the source of the reflection (wave centers).

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.<sup>8</sup> The electron wavelength counts in Fig. 3.1.2 matches the expected value of standing waves. It is a 10-wavelength radius from the particle core, referred to in earlier equations as  $K_e=10$ .

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>.

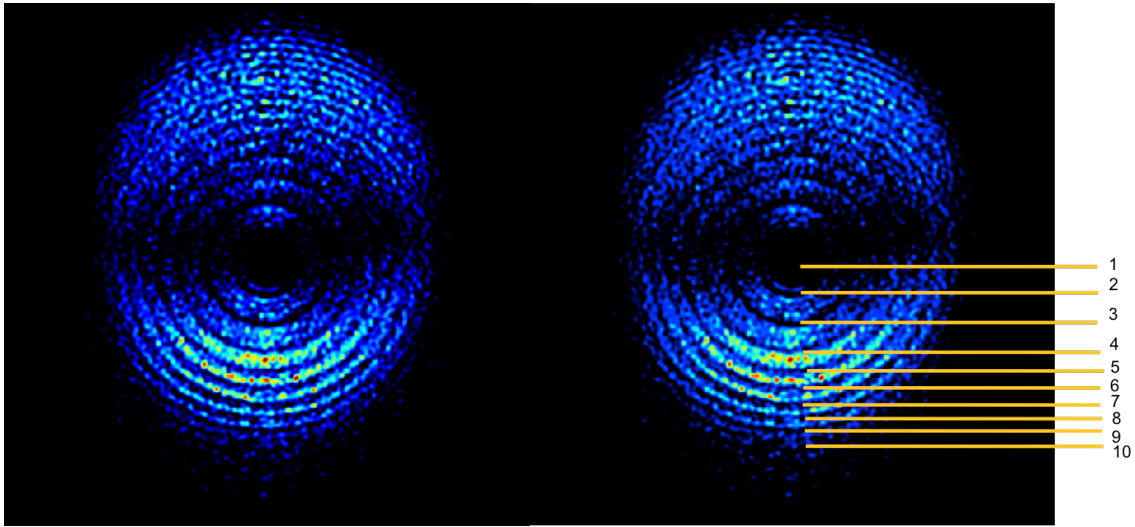


Fig 3.1.2 –Electron as Captured by Lund University (*wavelengths counted on image on right*)

### 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 ( $5K\lambda$ ), using the pentaquark model of the proton (see next section on Quarks). Since the proton is known to be a composite particle, it needed to be modeled as a combination of particles. Using a proposed tetrahedral geometric arrangement, the radius to the circumsphere of the new particle was calculated. The model is shown in Fig. 3.2.1 below.

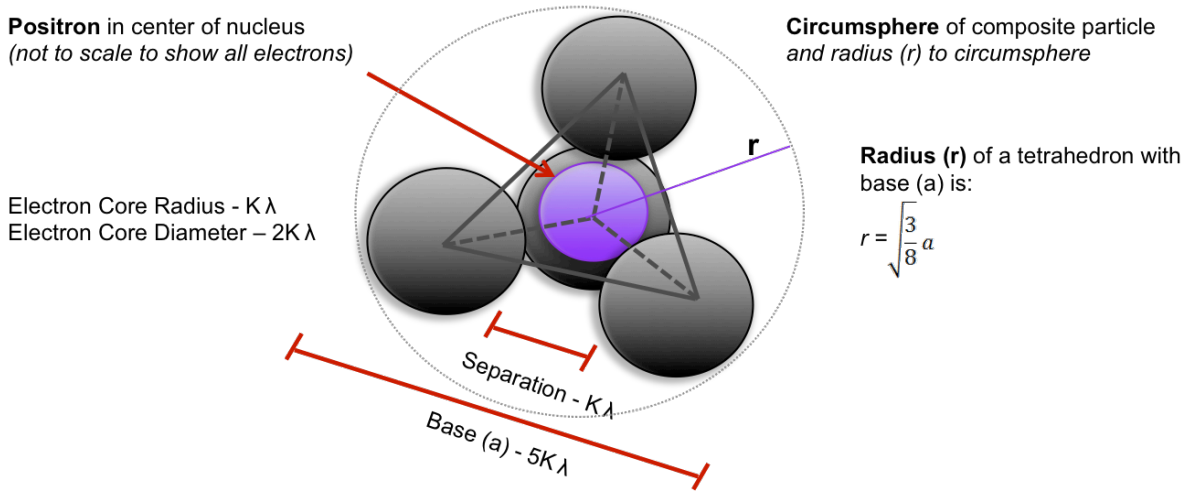


Fig 3.2.1 – Proton Proposed Model

The proton radius from Section 2.3 is derived as follows:

$$a = 5K_e \lambda_l \tag{3.2.1}$$

$$r_p = \sqrt{\frac{3}{8}} \cdot a \quad (3.2.2)$$

$$r_p = \sqrt{\frac{3}{8}} \cdot 5K_e \lambda_l \quad (3.3.3)$$

### Notes:

- The core of the proton is four electrons at the vertices of a tetrahedron.
- A separation distance between each of the four electron cores of  $K_e \cdot \lambda_l$  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 ( $K_e \cdot \lambda_l$ ) 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).<sup>9</sup>

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 an 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).

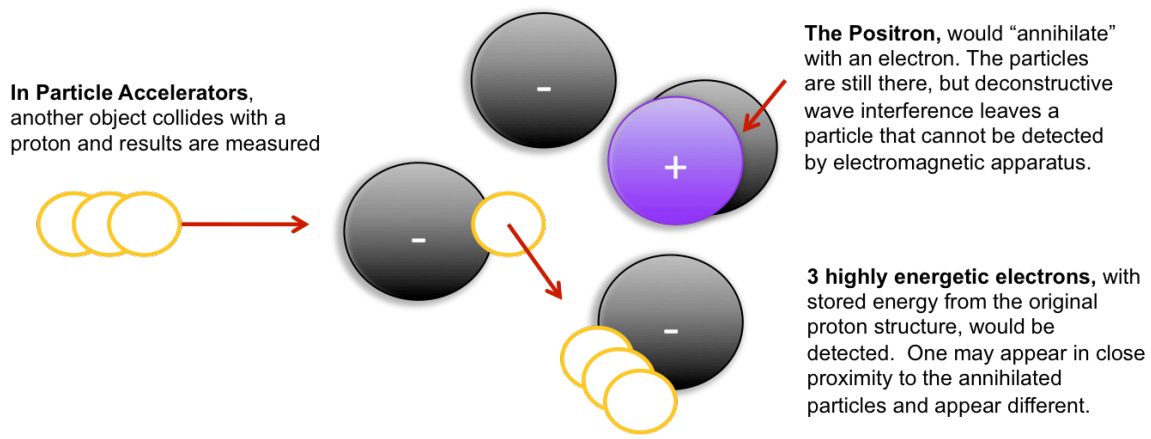


Fig 3.2.2 – Proton Collisions

This proposed model also fits 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 the 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  $+1/2$  or  $-1/2$ , giving the proton its spin.

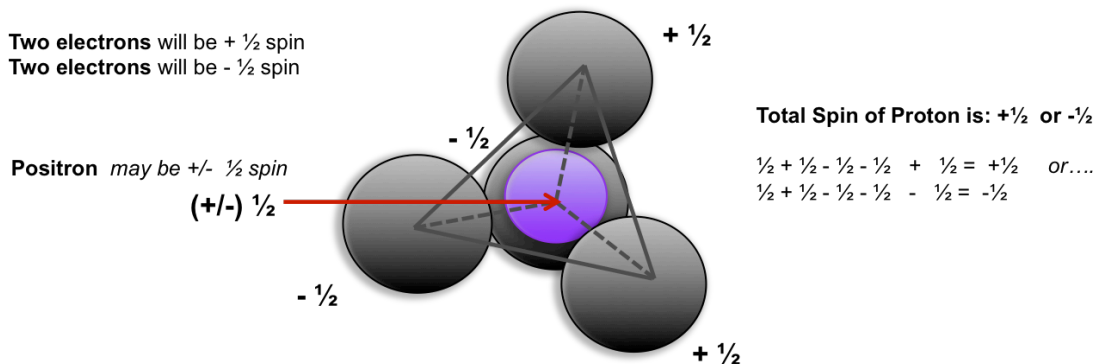


Fig 3.2.3 – Proton Spin

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 ( $+1/2$  and  $+1/2$ ; or  $-1/2$  and  $-1/2$ )
- **Green:** Two electrons of opposite spin ( $+1/2$  and  $-1/2$ )
- **Blue:** One electron and the combination of the electron affected by the annihilated electron-positron ( $+1/2$  and  $-1/2 + -1/2 + 1/2$ ; or  $-1/2$  and  $+1/2 + -1/2 + 1/2$ )

## 4. Conclusion

Twenty-three of the common fundamental physical constants were derived and calculated using energy wave equations in this paper. Although some of these constants required modification, there are only two g-factors used for most equations (the third is only used for the proton mass and ratio). The g-factors are similar in use to the g-factors for electron orbital and spin momentum used as correction factors in modern physics, but differ in value because different wave constants and values 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 equation from which it was derived also applies to electromagnetism and the strong force - unifying these forces together as one. In addition, the same energy 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 the *Particle Energy and Interaction, Forces* and *Atomic Orbitals* 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 energy wave equations, nor are they needed when expressing constants using a classical format after replacing the units of charge with the units of distance.

## Acknowledgements

These findings would not be possible without the research of the late Dr. Milo Wolff, Gabriel LaFreniere and Xavier Borg from whom this theory is based upon as a derivative of the Wave Structure of Matter (WSM). Special thanks to Oyvind Liberg, Lori Gardi, David de Hilster, Dr. Karoly Kehrer, Susan C. Barlow, Declan Trill, Michael Olley and Gary Simpson for reviewing components of this theory and providing valuable feedback. Lastly, my sincere appreciation to my family, who were considerably patient and understanding while I worked on this paper.

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<sup>8</sup> Science Daily, *Electron Gets Film Debut in First Ever Video*, Online: <http://www.sciencedaily.com/releases/2008/02/080222095358.htm> (February 2008).

<sup>9</sup> CERN, *CERN's LHCb experiment reports observation of exotic pentaquark particle*, Online: <http://press.cern/press-releases/2015/07/cerns-lhcb-experiment-reports-observation-exotic-pentaquark-particles> (July 2015).