

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 only **five** physical constants in two different formats: 1) classical constants used in mainstream physics and 2) new wave constants. In wave format, the constants are: wavelength, wave amplitude, wave speed, density and a dimensionless property of the electron. In classical format, the constants are four of the Planck constants and the electron's classical radius. All 23 fundamental physical constants presented in this paper can be derived from one of these five wave constants (20 in the case of the classical constants).

In both classical and wave formats, 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 five 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 has the ability to calculate particle energies beyond the electron, and forces as found in the *Particle Energy and Interaction*¹, *Forces*² and *Atomic Orbitals*³ papers. It would also explain why charge should be measured as meters – a measurement of displacement from equilibrium, otherwise known as 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.⁴ Only the radius of the proton exceeds an accuracy difference of 0.005%, however, the proton's exact radius is subject to debate.⁵

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 – 21 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_λ
Proton Mass	1.6276E-27	1.6276E-27	0.000%	g_p
Proton Radius	8.7516E-16	8.7389E-16	0.146%	
Bohr Radius	5.2918E-11	5.2918E-11	0.000%	g_λ
Electron Compton Wavelength	2.4263E-12	2.4263E-12	0.000%	g_λ
Rydberg Unit of Energy	2.1799E-18	2.1799E-18	0.000%	
Rydberg Constant	1.0974E+07	1.0974E+07	0.000%	g_λ^{-1}
Planck Constant	6.6261E-34	6.6261E-34	0.000%	g_λ
Planck Time	5.3912E-44	5.3912E-44	0.000%	g_λ^2
Planck Length	1.6162E-35	1.6162E-35	0.000%	g_λ^2
Planck Mass	2.1765E-08	2.1765E-08	0.000%	g_λ^{-1}
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	6.6741E-11	0.000%	g_λ^3
Avogadro Constant	6.0221E+23	6.0225E+23	-0.005%	g_λ^{-1}
Proton-Electron Mass Ratio	1836.153	1836.153	0.000%	g_p

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	m^{-1}	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	$\text{m}^2 \text{C} / \text{s}$	m^3 / 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	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	$\alpha_e = \frac{1}{4\pi^3 + \pi^2 + \pi}$	$\alpha_e = \frac{3\pi\lambda_l}{4K_e^4 A_l}$
Electron Rest Energy	$E_e = \frac{\alpha_e m_P l_P^3}{r_e t_P^2}$	$E_e = \frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3}$
Electron Mass	$m_e = \frac{\alpha_e m_P l_P}{r_e}$	$m_e = \frac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3}$
Electron Classical Radius	$r_e = \alpha_e^2 a_0$	$r_e = K_e^2 \lambda_l g_\lambda$
Proton Mass	N/A	$m_p = \frac{4\pi\rho K_e^8 A_l^6 O_e}{9\lambda_l^3} \sqrt{\frac{\lambda_l}{A_l}} \cdot g_p$
Proton Radius	N/A	$r_p = \sqrt{\frac{3}{8}} \cdot 5K_e \lambda_l$
Bohr Radius	$a_0 = \frac{r_e}{\alpha_e^2}$	$a_0 = \frac{1}{\lambda_l} \left(\frac{4K_e^5 A_l}{3\pi} \right)^2 g_\lambda$
Electron Compton Wavelength	$\lambda_C = \frac{2\pi r_e}{\alpha_e}$	$\lambda_C = \frac{8K_e^6 A_l}{3} g_\lambda$
Rydberg Unit of Energy	$R_y = \frac{m_P l_P^3 \alpha_e^3}{2r_e t_P^2}$	$R_y = \frac{3\pi^3 \rho A_l^4 c^2 O_e}{8K_e^3 \lambda_l}$
Rydberg Constant	$R_\infty = \frac{\alpha_e^3}{4\pi r_e}$	$R_\infty = \left(\frac{\pi\lambda_l}{2K_e^7} \right)^2 \left(\frac{3}{4A_l} \right)^3 g_\lambda^{-1}$
Planck Constant	$h = \frac{2\pi m_P l_P^2}{t_P}$	$h = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda$

Planck Time	$t_P = \frac{l_P}{c}$	$t_P = \frac{1}{\sqrt{2}} \frac{\lambda_l^2}{12\pi K_e^{18} A_l c} g_\lambda^2$
Planck Length	$l_P = t_P c$	$l_P = \frac{1}{\sqrt{2}} \frac{\lambda_l^2}{12\pi K_e^{18} A_l} g_\lambda^2$
Planck Mass	$m_P = \frac{\mu_0 q_P^2}{4\pi l_P}$	$m_P = \sqrt{2} \cdot \frac{64\pi \rho K_e^{29} A_l^8 O_e}{3\lambda_l^5} g_\lambda^{-1}$
Planck Charge	$q_P = \frac{e_e}{\sqrt{\alpha_e}}$	$q_P = 2A_l g_A^{-1}$
Elementary Charge	$e_e = q_P \sqrt{\alpha_e}$	$e_e = \sqrt{\frac{3\pi \lambda_l A_l}{K_e^4}} \cdot g_A^{-1}$
Coulomb Constant	$k_e = \frac{m_P l_P^3}{q_P^2 t_P^2}$	$k_e = \frac{4\rho K_e^{11} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2$
Electric Constant	$\epsilon_0 = \frac{q_P^2 t_P^2}{4\pi m_P l_P^3}$	$\epsilon_0 = \frac{9\lambda_l^3}{16\pi \rho K_e^{11} A_l^5 c^2 O_e} g_\lambda^{-1} g_A^{-2}$
Magnetic Constant	$\mu_0 = \frac{4\pi m_P l_P}{q_P^2}$	$\mu_0 = \frac{16\pi \rho K_e^{11} A_l^5 O_e}{9\lambda_l^3} g_\lambda g_A^2$
Bohr Magneton	$\mu_B = \frac{l_P q_P r_e}{2t_P \sqrt{\alpha_e}}$	$\mu_B = 2K_e^4 c \sqrt{\frac{\lambda_l A_l^3}{3\pi}} \cdot g_\lambda g_A^{-1}$
Gravitational Constant	$G = \frac{l_P c^2}{m_P}$	$G = \frac{\lambda_l^7 c^2}{\pi^2 \rho K_e^{47} O_e (2A_l)^9} g_\lambda^3$
Avogadro Constant	$N_A = \frac{r_e}{2l_P \alpha_e^2}$	$N_A = \sqrt{2} \cdot \frac{32K_e^{28} A_l^3}{3\pi \lambda_l^3 e} g_\lambda^{-1}$
Proton-Electron Mass Ratio	N/A	$\frac{m_p}{m_e} = \frac{K_e^3}{3} \sqrt{\frac{\lambda_l}{A_l}} \cdot g_p$

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 (λ – electron orbital g-factor, Λ – 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)
Wave Constants		
A_l	Amplitude (longitudinal)	$9.215405708 \times 10^{-19}$ (m)
λ_l	Wavelength (longitudinal)	$2.854096501 \times 10^{-17}$ (m)
ρ	Density (aether)	$3.859764540 \times 10^{22}$ (kg/m ³)
c	Wave velocity (speed of light)	299,792,458 (m/s)
Variables		
δ	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>
Particle Constants		
K_e	Electron particle count	10 - <i>dimensionless</i>

O_e	Electron outer shell multiplier	2.138743820 – <i>dimensionless</i>
g_λ	Electron orbital g-factor (<i>revised</i>)	0.9873318320 – <i>dimensionless</i>
g_Λ	Electron spin g-factor (<i>revised</i>)	0.9826905018 – <i>dimensionless</i>
g_p	Proton orbital g-factor (<i>revised</i>)	0.9898125300 – <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 $\{\alpha_e\}$:

$$A_l = \{\alpha_e^{-1}\} \frac{3\pi\lambda_l}{4K_e^4} \quad (1.1.2)$$

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

$$\rho = \{h\} \frac{9\lambda_l^3}{32\pi K_e^{11} A_l^7 c O_e} g_\lambda^{-1} \quad (1.1.3)$$

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.⁶ 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.

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

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

$$g_p = \{m_p\} \frac{9\lambda_l^3}{4\pi\rho K_e^8 A_l^6 O_e} \sqrt{\frac{A_l}{\lambda_l}} \quad (1.1.8)$$

1.2. Classical Format Constants

This paper also derives fundamental physical constants in terms of other physical constants established in modern physics, removing the need for proportionality constants like the gravitational constant (G) and the Planck constant (h). When using the classical formats, all electron-based constants (20 total) may also be reduced to be derived from only five constants – just like the wave equation format. Using either format, classical or wave, leads to the same results. The wave constants are preferred in energy wave theory (EWT) because of their ability to calculate particle energies beyond the electron.

All of the classical constants in this paper can be derived from four Planck constants and the electron's radius, shown in detail in the *Geometry of Spacetime and the Unification of Electromagnetic, Gravitational and Strong Forces paper*.⁷ The five fundamental constants are based on single units and their values are the assumed to be the latest CODATA values:

1. l_p – Planck length (meters)
2. t_p – Planck time (seconds)
3. m_p – Planck mass (kilograms)
4. q_p – Planck charge (meters)
5. r_e – Electron radius (meters)

A sixth constant appears in the derivations but is considered a geometric ratio (mathematical constant) and not a fundamental constant, much like how π appears in equations without being considered a physical constant. The fine

structure constant is used for readability instead of showing its geometric representation. Its derivation and the relationship to π is shown in Section 2.18.

6. α_e – Fine structure constant (dimensionless)

The five fundamental constants are set to well-known and measured constants in physics. For example, the relationship of the Planck length and Planck time become the speed of light constant (c), as illustrated in the next equation:

$$c = \frac{l_P}{t_P} = 2.99792 \cdot 10^8 \left(\frac{m}{s} \right) \quad (1.2.1)$$

The five constants are set to the following, shown in more detail in their respective sections:

- c – Speed of light (Planck length and Planck time)
- μ_0 – Magnetic constant (Planck mass)
- e_e – Elementary charge (Planck charge)
- a_0 – Bohr radius (electron radius)

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 five 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).

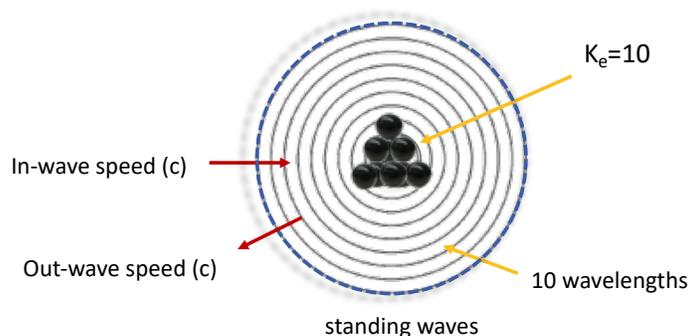


Fig 2.1.1 – Electron rest energy is standing waves of stored energy within the defined perimeter (blue dashed line)

Classical Format

In terms of the five fundamental classical constants:

$$E_e = \frac{\alpha_e m_P l_P^3}{r_e l_P^2} \quad (2.1.1)$$

The electron's energy is expressed an alternative way with the magnetic constant (μ_0), elementary charge (e_e) and speed of light (c) which will relate the electron's energy to Coulomb's energy in a later section.

$$E_e = \frac{\mu_0 e_e^2 c^2}{4\pi r_e} \quad (2.1.2)$$

Wave Equation Format

$$E_e = \frac{4\pi \rho K_e A_l^6 c^2 O_e}{3\lambda_l^3} \quad (2.1.3)$$

Calculated Value: 8.1871E-14

Difference from CODATA: 0.000%

Calculated Units: Joules (kg m²/s²)

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), which is expressed in the second classical format version (Eq. 2.1.5). Mass is simply standing, longitudinal waves of energy.

Classical Format

In terms of the five fundamental constants:

$$m_e = \frac{\alpha_e m_P l_P}{r_e} \quad (2.1.4)$$

Expressed with the magnetic constant (μ_0), elementary charge (e_e), demonstrating that the difference between energy and mass is the removal of c^2 in the equation (compared with Eq. 2.1.2).

$$m_e = \frac{\mu_0 e_e^2}{4\pi r_e} \quad (2.1.5)$$

Wave Equation Format

$$m_e = \frac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3} \quad (2.1.6)$$

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 $10 * A_l$ (amplitude) at the core; likewise, wavelength becomes $10 * \lambda_l$ (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.

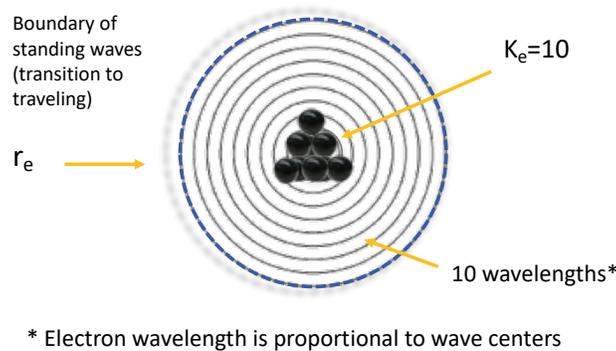


Fig 2.2.1 – Electron radius is the perimeter where standing waves transition to traveling waves

Classical Format

The electron's classical radius is one of the five fundamental constants from which all other classical constants can be derived. Here, it is related to the Bohr radius (a_0).

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

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_λ

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

$$r_p = \sqrt{\frac{3}{8}} \cdot 5K_e \lambda_l \quad (2.3.1)$$

Calculated Value: 8.7389E-16

Difference from CODATA: 0.146%

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.⁸

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_1) on the electron. There is a repelling force (F_2) 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.

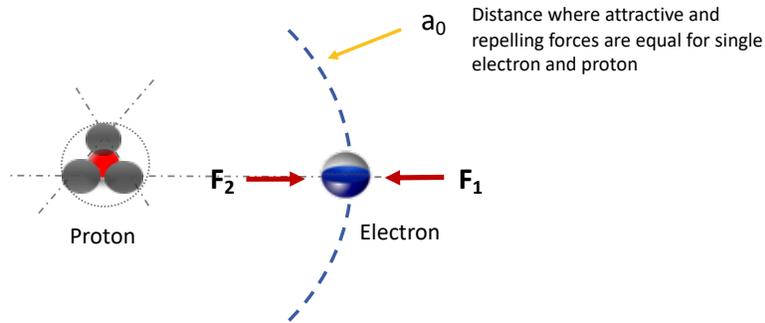


Fig 2.4.1 – Bohr radius is the distance where attractive and repelling forces are equal for a single electron and proton

Classical Format

$$a_0 = \frac{r_e}{\alpha_e^2} \tag{2.4.1}$$

Wave Equation Format

$$a_0 = \frac{1}{\lambda_l} \left(\frac{4K_e^5 A_l}{3\pi} \right)^2 g_\lambda \tag{2.4.2}$$

Calculated Value: 5.2918E-11

Difference from CODATA: 0.000%

Calculated Units: meters (m)

G-Factor: g_λ

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.

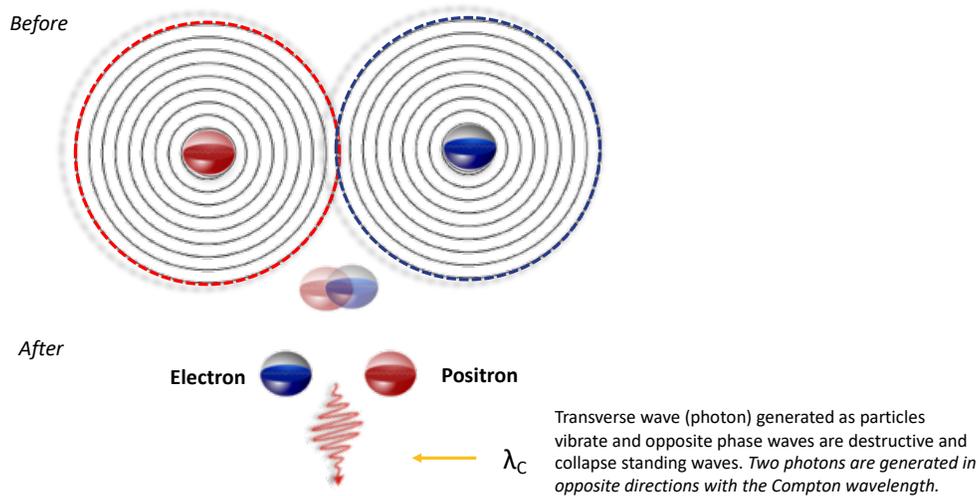


Fig 2.5.1 – Compton wavelength of photon generated as electron and positron vibrate and generate a transverse (annihilation)

Classical Format

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

Wave Equation Format

$$\lambda_C = \frac{8K_e^6 A_l}{3} g_\lambda \quad (2.5.2)$$

Calculated Value: 2.4263E-12

Difference from CODATA: 0.000%

Calculated Units: meters (m)

G-Factor: g_λ

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.

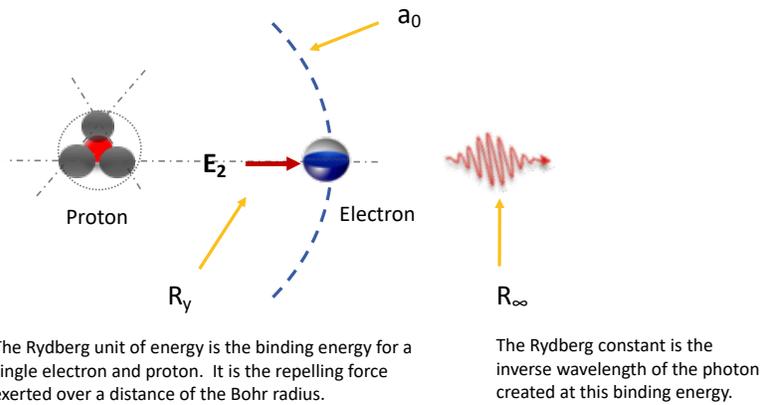


Fig 2.6.1 – Rydberg unit of energy and Rydberg constant express the binding energy of hydrogen in different terms

Classical Format

In terms of the five fundamental constants:

$$R_y = \frac{m_P l_P^3 \alpha_e^3}{2 r_e t_P^2} \quad (2.6.1)$$

The Rydberg energy is expressed an alternative way with the magnetic constant (μ_0), elementary charge (e) and speed of light (c) which will relate the Rydberg energy to Coulomb's energy in a later section.

$$R_y = \frac{\mu_0 e^2 c^2}{8 \pi a_0} \quad (2.6.2)$$

Wave Equation Format

$$R_y = \frac{3 \pi^3 \rho A_l^4 c^2 O_e}{8 K_e^3 \lambda_l} \quad (2.6.3)$$

Calculated Value: 2.1799E-18

Difference from CODATA: 0.000%

Calculated Units: Joules (kg m²/s²)

Rydberg Constant (meters⁻¹)

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

$$R_{\infty} = \frac{\alpha_e^3}{4\pi r_e} \quad (2.6.4)$$

Wave Equation Format

$$R_{\infty} = \left(\frac{\pi \lambda_l}{2K_e^7} \right)^2 \left(\frac{3}{4A_l} \right)^3 g_{\lambda}^{-1} \quad (2.6.5)$$

Calculated Value: 1.0974E+07

Difference from CODATA: 0.000%

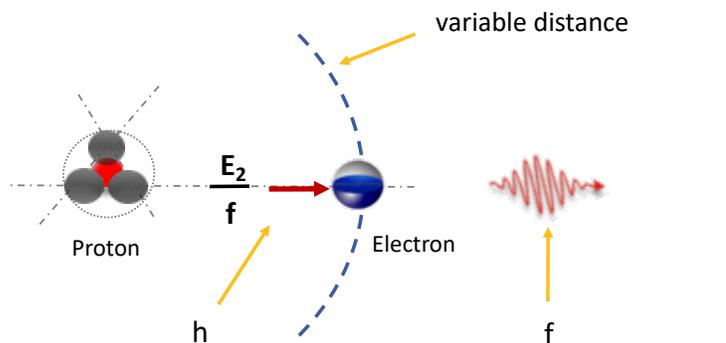
Calculated Units: m⁻¹

G-Factor: g_λ⁻¹

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.



Planck constant represents a handful of constants in the binding energy between a proton and electron, where the variables for electron distance and wave interference are separated as variables for photon frequency.

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

Classical Format

In terms of the five fundamental constants:

$$h = \frac{2\pi m_P l_P^2}{t_P} \quad (2.7.1)$$

The Planck constant is expressed an alternative way with the magnetic constant (μ_0), Planck charge (q_P) and speed of light (c), as it will relate the transverse Planck energy to Coulomb's energy in a later section.

$$h = \frac{\mu_0 q_P^2 c}{2} \quad (2.7.2)$$

Wave Equation Format

$$h = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda \quad (2.7.3)$$

Calculated Value: 6.6261E-34

Difference from CODATA: 0.000%

Calculated Units: kg m² / s

G-Factor: g_λ

2.8. Planck Length

Planck length is a fundamental classical constant, setting the baseline for the unit of length. In the *Geometry of Spacetime* paper, the Planck units are described as the components of spacetime, referred to as *granules*, which can be modeled classically as a spring-mass system to derive fundamental physical constants where only five fundamental constants are required. The following figure describes the relationship of four of these Planck constants. The Planck length is the radius of a single granule. The harmonic motion of granules in the system that creates the presence of waves, which is why the constants can also be represented in wave format.

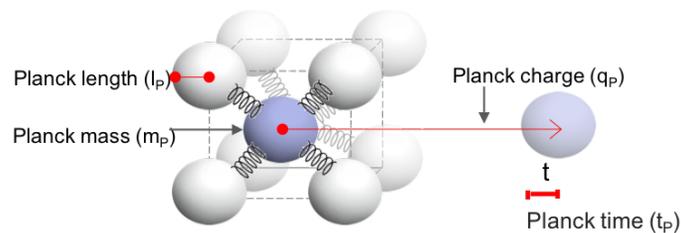


Fig 2.8.1 – The relationship of the Planck constants



Fig 2.8.2 – Planck length is the radius of a granule

Classical Format

The Planck length is one of the five fundamental constants from which all other classical constants can be derived. Here, it is related to the speed of light (c) as the length that a granule travels in a timeframe of Planck time at speed c .

$$l_P = t_P c \tag{2.8.1}$$

Wave Equation Format

$$l_P = \frac{1}{\sqrt{2}} \frac{\lambda_l^2}{12\pi K_e^{18} A_l} g_\lambda^2 \tag{2.8.2}$$

Calculated Value: 1.6162E-35

Difference from CODATA: 0.000%

Calculated Units: m

G-Factor: g_λ^2

2.9. Planck Time

Planck time is a fundamental classical constant, setting the baseline for the unit of time, based on the speed of and length of granules in the spacetime lattice. The figure describing a unit cell in the lattice structure from the *Geometry of Spacetime* paper is shown again in the next figure.

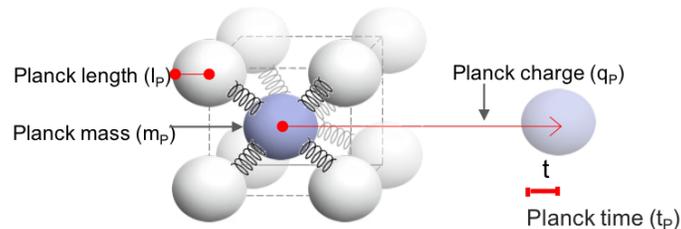


Fig 2.9.1 – The relationship of the Planck constants

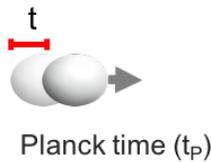


Fig 2.9.2 – Planck time is the time that it takes for a granule in motion to move a distance of Planck time

Classical Format

Planck time is one of the five fundamental constants from which all other classical constants can be derived. Here it is related to the speed of light (c) based on the time it takes to travel a Planck length (l_P) at that speed.

$$t_P = \frac{l_P}{c} \quad (2.9.1)$$

Wave Equation Format

$$t_P = \frac{1}{\sqrt{2}} \frac{\lambda_l^2}{12\pi K_e^{18} A_l c} g_\lambda^2 \quad (2.9.2)$$

Calculated Value: 5.3912E-44

Difference from CODATA: 0.000%

Calculated Units: seconds (s)

G-Factor: g_λ^2

2.10. Planck Mass

The Planck mass is a fundamental classical constant, setting the baseline for the unit of mass. It *represents* the mass of a wave center. Although it is a large mass for a small component of space – a wave center has a radius of Planck length – its energy/mass is only recognized when it is in motion, consistent with the mechanics of a spring-mass system. The relationship of the Planck constants and the spring-mass system is shown once again:

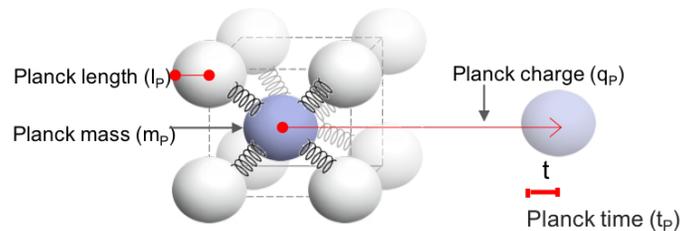


Fig 2.10.1 – The relationship of the Planck constants

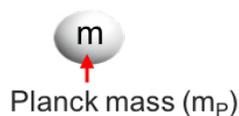


Fig 2.10.2 – Planck mass is the mass of a single granule in the spacetime lattice

Classical Format

Planck mass is a fundamental classical constant, setting the baseline for the unit of mass. Here, it is set to the magnetic constant (μ_0). It will also be shown to be related to Coulomb energy/mass in a later section.

$$m_P = \frac{\mu_0 q_P^2}{4\pi l_P} \quad (2.10.1)$$

Wave Equation Format

$$m_P = \sqrt{2} \cdot \frac{64\pi\rho K_e^{29} A_l^8 O_e^{-1}}{3\lambda_l^5} g_\lambda^{-1} \quad (2.10.2)$$

Calculated Value: 2.1765E-08

Difference from CODATA: 0.000%

Calculated Units: kg

G-Factor: g_λ^{-1}

2.11. Planck Charge

The Planck charge is a measurement of total granule displacement at the first wavelength from the electron's core, where wave centers reflect in-waves to become standing waves. As a displacement, it is appropriately measured as a distance (meters). Planck charge is total displacement (peak-to-peak), while amplitude A_l is half of this displacement (equilibrium-to-peak). This is expressed in wave constant form in Eq. 2.11.2. In classical format, it is set to the elementary charge. 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).

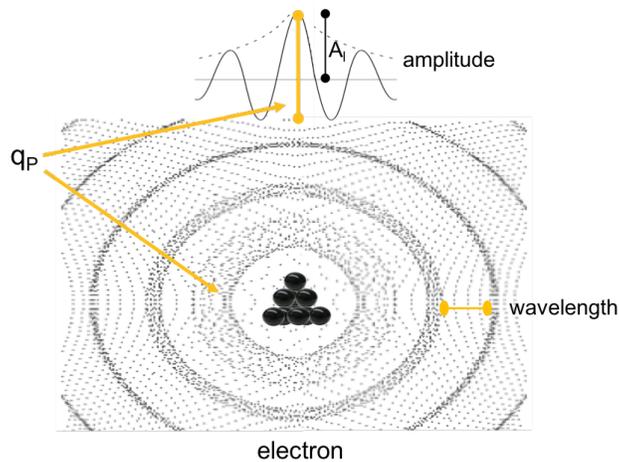


Fig 2.11.1 – Electron's standing waves. Planck charge is the total displacement of a granule (2 times amplitude).

Classical Format

Planck charge is a fundamental classical constant, setting the baseline for charge, which is best described as initial wave amplitude. Here, it is set to the elementary charge (e_e).

$$q_P = \frac{e_e}{\sqrt{\alpha_e}} \quad (2.11.1)$$

Wave Equation Format

$$q_P = 2A_l g_A^{-1} \quad (2.11.2)$$

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

Like the Planck charge, the elementary charge is also longitudinal displacement of a granule. The elementary charge is the displacement of granules away from the center, spreading spherically as they transfer energy to a greater number of granules in the lattice, losing wave amplitude proportional to the distance from the center. At the center of the electron, some energy is converted to transverse energy (magnetic spin), slightly reducing longitudinal displacement. The longitudinal displacement at the electron core becomes the elementary charge.

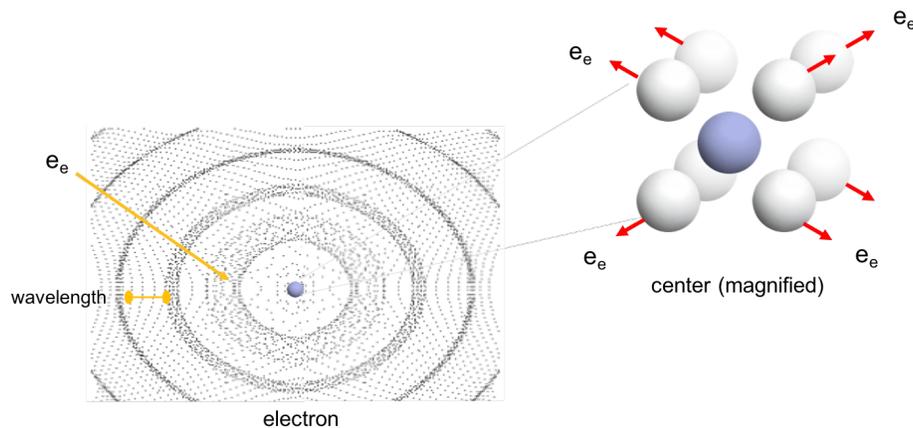


Fig 2.12.1 – The elementary charge is the longitudinal displacement of granules at the first wavelength at the electron's core.

Classical Format

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

Wave Equation Format

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

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 next figure illustrates wave motion in the universe. In the absence of any particles, there would still be energy as a result of this motion and the force would be Coulomb's constant, i.e. $F=k_e$. When there are particles, such as two electrons separated at distance (r), it is an electric force that is attractive or repulsive based on the constructive interference of traveling waves between the particles.

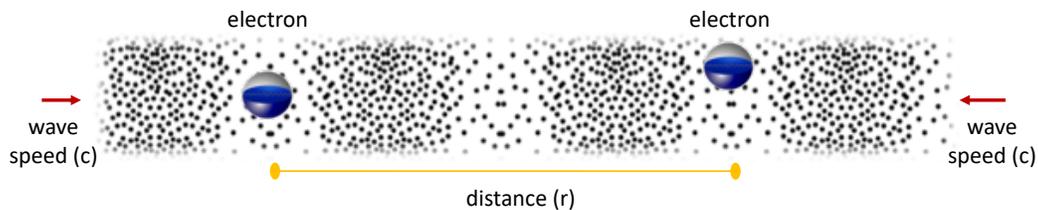


Fig 2.13.1 – Coulomb's constant represents a universal force that is affected by constructive wave interference between particles

In the *Geometry of Spacetime* paper, the Coulomb force was found to be at the Planck level, as the force between two granules. The Coulomb force is modeled classically as a spring-mass system in the paper, and thus pictured in the next illustration as a spring in a spring-mass system.

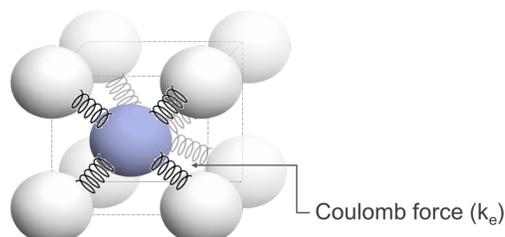


Fig 2.13.1 – Coulomb’s constant can be found at the granular level, classically modeled as the force between granules in a spring-mass system

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.

Classical Format

In terms of the five fundamental constants:

$$k_e = \frac{m_P l_P^3}{q_P^2 t_P^2} \tag{2.13.1}$$

The Coulomb constant is expressed an alternative way with the magnetic constant (μ_0) and speed of light (c), to compare it to previous energy and mass equations. See further details below in this section.

$$k_e = \frac{\mu_0 c^2}{4\pi} \tag{2.13.2}$$

Wave Equation Format

$$k_e = \frac{4\rho K_e^{11} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2 \tag{2.13.3}$$

Calculated Value: 8.9876E+9

Difference from CODATA: 0.000%

Calculated Units: kg m / s²

G-Factors: g_λ, g_A^2

Note: The above units are based in kg * m/s². By comparison the Coulomb constant (k) is measured in N * m²/C². 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/s², 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:

$$\frac{Nm^2}{C^2} = \frac{kg(m)}{s^2} \frac{m^2}{m^2} = \frac{kg(m)}{s^2} \tag{2.13.4}$$

Coulomb Energy

The previous energy and mass equations were separated with an alternative derivation to show the consistency of the Coulomb energy across all equations. The Coulomb energy is constant across particles, photons and forces. The components of the Coulomb constant from Eq. 2.13.2 is found in the next equation as it is expanded to be an energy equation by multiplying amplitude (squared) and dividing by the distance (radius).

$$E = \frac{\mu_0 c^2}{4\pi} \frac{(\text{amplitude})^2}{(\text{radius})} \quad (2.13.5)$$

The only difference in the energy equations is the initial wave amplitude, which is squared, and the radius or distance between two points being measured. For example, the electron's energy is based on the elementary charge (spherical wave amplitude) and the electron's radius where standing waves cease before becoming traveling waves. For the electron's mass, simply remove c^2 .

$$E_e = \frac{\mu_0 c^2}{4\pi} \left(\frac{e_e^2}{r_e} \right) \quad (2.13.6)$$

The only difference between this energy and a force, is that radius is squared in a force. For example, the electric force of two electrons (Coulomb's law) is the same equation as Eq. 2.13.5, but now with a variable distance (r), and also squared because it is a force.

$$F_e = \frac{\mu_0 c^2}{4\pi} \left(\frac{e_e^2}{r^2} \right) \quad (2.13.7)$$

The Rydberg energy, which is for an electron at the Bohr radius (a_0), illustrates that the energy continues from the electron's core as traveling waves (now $\frac{1}{2}$ as it will eventually need two electrons in an orbit to be stable). Other than the factor of $\frac{1}{2}$, only the distance changes in the denominator from the electron's radius, to the Bohr radius for the electron in an orbit of hydrogen.

$$R_y = \frac{1}{2} \frac{\mu_0 c^2}{4\pi} \left(\frac{e_e^2}{a_0} \right) \quad (2.13.8)$$

Other energy and mass equations follow the same format. One-dimensional energies and forces, such as photons or the strong force, will use the Planck charge as amplitude instead of the elementary charge.

2.14. Electric Constant (Vacuum Permittivity)

The electric constant is the inverse of $4\pi k_e$ (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

$$\epsilon_0 = \frac{q_P^2 l_P^2}{4\pi m_P l_P^3} \quad (2.14.1)$$

Wave Equation Format

$$\epsilon_0 = \frac{9\lambda_l^3}{16\pi\rho K_e^{11} A_l^5 c^2 O_e} g_\lambda^{-1} g_A^{-2} \quad (2.14.2)$$

Calculated Value: 8.8542E-12

Difference from CODATA: 0.000%

Calculated Units: s² / kg m

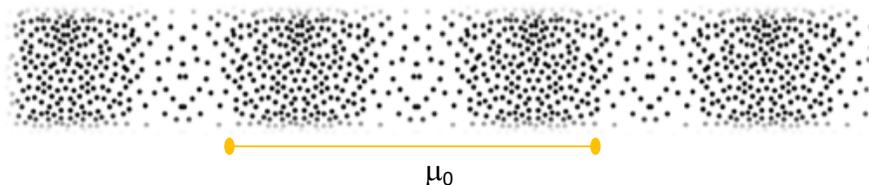
G-Factors: g_λ⁻¹, g_A⁻²

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)

Similar to how the speed of light constant relates two fundamental units of distance and time, the magnetic constant relates two fundamental units of mass and distance, resolving to become the equivalent of a linear density. The units, which are derived later in this section, resolve to be the equivalent of a kilograms per meter. The detailed derivation of the magnetic constant can be found in the *Geometry of Spacetime* paper.

Waves travel in a medium, as illustrated in Fig. 2.15.1. The magnetic constant represents the amount of granules 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

$$\mu_0 = \frac{4\pi m_P l_P}{q_P^2} \quad (2.15.1)$$

Wave Equation Format

$$\mu_0 = \frac{16\pi\rho K_e^{11} A_l^5 O_e}{9\lambda_l^3} g_\lambda g_A^2 \quad (2.15.2)$$

Calculated Value: 1.2566E-6

Difference from CODATA: 0.000%

Calculated Units: kg / m

G-Factors: g_λ, g_A^2

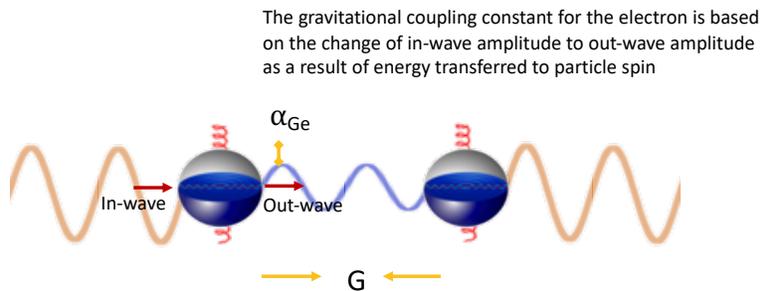
Note: The units are measured in kg/m compared with H/m for the magnetic constant, where H is Henries. When Henries is derived in SI units to Coulombs and replaced with meters, the units resolve correctly to kg/m.

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

2.16. Gravitational Constant & Gravitational Coupling Constant

Gravitational Coupling Constant (Electron)

The Gravitational constant (G) was derived in detail in classical format in the *Geometry of Spacetime* paper and in wave format in the *Forces* paper; both after deriving the gravitational coupling constants for the electron (α_{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. 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 as a result of a geometric transformation at the core of a particle. The proposed reason for the amplitude reduction is the transfer of the energy for particle spin. This is illustrated in the next figure.



Particles motion is a result of a shading effect of unequal wave amplitude, creating a force between particles. The constants in the force equation are represented by G.

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

Classical Format

$$\alpha_{Ge} = \frac{\alpha l_P^2}{r_e^2} \quad (2.16.1)$$

Wave Equation Format

$$\alpha_{Ge} = \frac{K_e}{6\pi} \left(\frac{\lambda_l}{4K_e^{15} A_l} \right)^3 g_\lambda^2 \quad (2.16.2)$$

Gravitational Coupling Constant (Electron): 2.4005E-43

Calculated Units: None (*dimensionless*)

Gravitational Constant

In both the *Geometry of Spacetime* and *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.

Classical Format

$$G = \frac{l_P c^2}{m_P} \quad (2.16.3)$$

Wave Equation Format

$$G = \frac{\lambda_l^7 c^2}{\pi^2 \rho K_e^{47} O_e (2A_l)^9} g_\lambda^3 \quad (2.16.4)$$

Calculated Value: 6.6741E-11

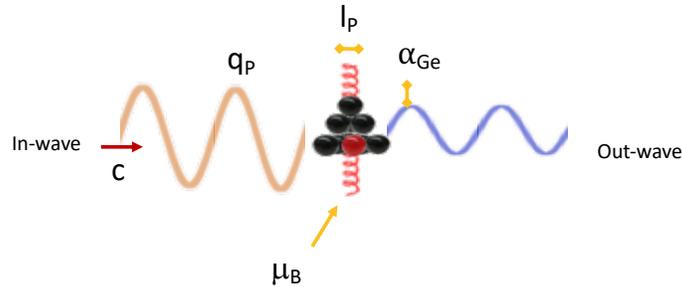
Difference from CODATA: 0.000%

Calculated Units: m³ / s² kg

G-Factor: gλ³

2.17. Bohr Magnetron

Like the gravitational constant, the Bohr magneton is derived classically in the *Geometry of Spacetime* paper and in wave format 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 magneton 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 magnetron represents a transverse wave created as the electron spins

Classical Format

$$\mu_B = \frac{l_p q_p r_e}{2 t_p \sqrt{\alpha_e}} \quad (2.17.1)$$

Wave Equation Format

$$\mu_B = 2 K_e^4 c \sqrt{\frac{\lambda_l A_l^3}{3\pi}} \cdot g_\lambda g_A^{-1} \quad (2.17.2)$$

Calculated Value: 9.2740E-24

Difference from CODATA: 0.000%

Calculated Units: m³ / s

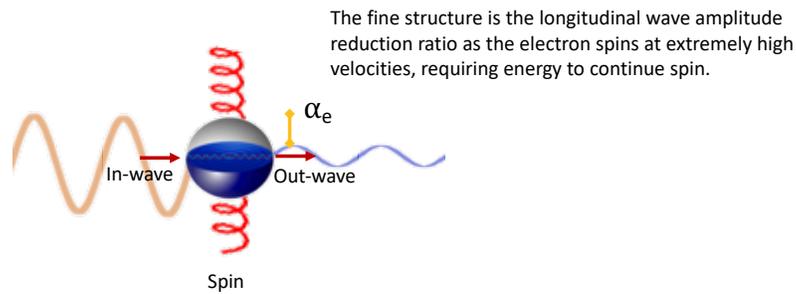
G-Factors: g_λ, g_A⁻¹

Note: The above units are based in m³/s. By comparison the Bohr Magnetron is measured in J/T (Joules per Tesla). Joules are measured in kg * m²/s². 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:

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

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 as a ratio of geometries as the wave changes from one-dimensional to three-dimensional, or vice versa. It is captured as the surface areas that the wave passes through, either as a rectangular cross-section, or a spherical surface area and surface area of a cone. Three coupling constants share this same geometry, with only a difference in the variables of the length and width of the geometry. The details are illustrated in the *Geometry of Spacetime* paper and summarized here in this section.



The inverse of the fine structure is the increase in wave amplitude along an axis as a result of the particle spinning.

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

Classical Format

$$\alpha_e = \frac{1}{4\pi^3 + \pi^2 + \pi} \quad (2.18.1)$$

Wave Equation Format

$$\alpha_e = \frac{3\pi\lambda_l}{4K_e^4 A_l} \quad (2.18.2)$$

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. The magnetic coupling constant is found in the orbits of atoms (see *Atomic Orbitals* paper). There are similarities when comparing the coupling constants. They are all based on a single equation that models the surface area of a rectangle versus sphere+cone as illustrated in the next figure:

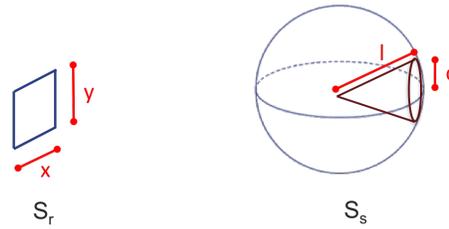


Fig. 2.18.2 – Surface areas of rectangle (S_r) and unit cell of a sphere+cone (S_s)

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

$$\frac{(x)(y)}{4\pi(l)^2 + (\pi d(l) + \pi d^2)} \quad (2.18.3)$$

Three of the coupling constants can now be derived directly from the previous equation:

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

All variables from Eq. 2.18.3 are set to the electron's radius (r_e):

$$\alpha = \frac{r_e^2}{4\pi(\pi r_e)^2 + (\pi r_e(\pi r_e) + \pi r_e^2)} = \frac{1}{4\pi^3 + \pi^2 + \pi} = 0.00729734 \quad (2.18.4)$$

Fine Structure Constant (Strong Force)

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

The variables for the sides of the rectangle from Eq. 2.18.3 are set to Planck length (l_p) and the cone radius and slant length are set to the electron's radius (r_e):

$$\alpha_{Ge} = \frac{l_p^2}{4\pi(\pi r_e)^2 + (\pi r_e(\pi r_e) + \pi r_e^2)} = \frac{l_p^2}{r_e^2(4\pi^3 + \pi^2 + \pi)} = \frac{\alpha l_p^2}{r_e^2} = 2.4006 \cdot 10^{-43} \quad (2.18.5)$$

Gravitational Coupling Constant - Electron

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

The same variables as the strong force are used for Eq. 2.18.3, with the exception of the y distance for the rectangle. It is a variable distance (r) as the electron's distance from a nucleus will vary based on the atomic element. Thus, it cannot be solved directly – the use of the equation is found in calculations in the *Atomic Orbitals* paper where radius is known for each element.

$$a_{Me} = \frac{r_e(r)}{4\pi(\pi r_e)^2 + (\pi r_e(\pi r_e) + \pi r_e^2)} = \frac{r_e(r)}{r_e^2(4\pi^3 + \pi^2 + \pi)} = \frac{ar}{r_e} \quad (2.18.6)$$

Magnetic Coupling Constant

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

$$m_p = \frac{4\pi\rho K_e^8 A_l^6 O_e}{9\lambda_l^3} \sqrt{\frac{\lambda_l}{A_l}} \cdot g_p \quad (2.19.1)$$

Calculated Value: 1.6726E-27

Difference from CODATA: 0.000%

Calculated Units: kg

G-Factor: g_p

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_0), Planck length (l_p) and the mathematical constant (e), as explained and derived in the *Geometry of Spacetime*. Here, it is further derived based on the derivation of the Bohr radius and its relation to the electron's radius and fine structure constant. Note that “e” in Eqs. 2.20.1 and 2.20.2 is the mathematical constant (e), not the elementary charge (e_e).

Classical Format

$$N_A = \frac{r_e}{2l_p \alpha_e^2 e} \quad (2.20.1)$$

Wave Equation Format

$$N_A = \sqrt{2} \cdot \frac{32K_e^{28} A_l^3}{3\pi \lambda_l^3 e} g_\lambda^{-1} \quad (2.20.2)$$

Calculated Value: 6.0225E+23

Difference from CODATA: -0.005%

Calculated Units: None (*dimensionless*)

G-Factor: g_λ^{-1}

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

$$\frac{m_p}{m_e} = \frac{K_e^3}{3} \sqrt{\frac{\lambda_l}{A_l}} \cdot g_p \quad (2.21.1)$$

Proton – Electron Mass Ratio

Calculated Value: 1836.153

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 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

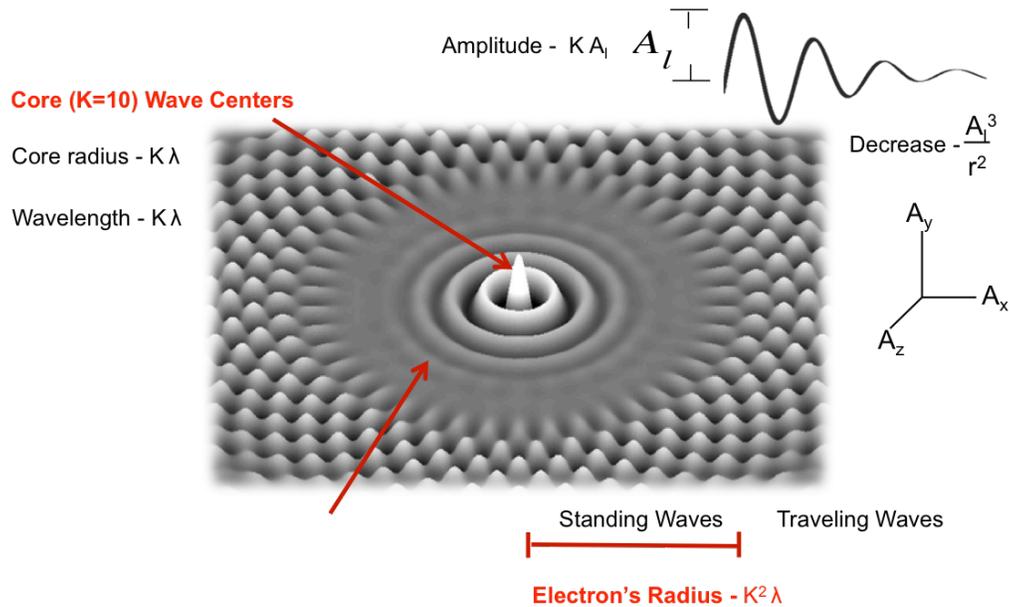
The electron is comprised of standing waves of energy. Traveling waves, throughout the universe, consist of energy with a given amplitude and wavelength. Particles, such as the electron, have wave centers that reflect these waves. Wave centers may combine, similar to how protons and neutrons form to 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 (λ) 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_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 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.⁹ 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>.

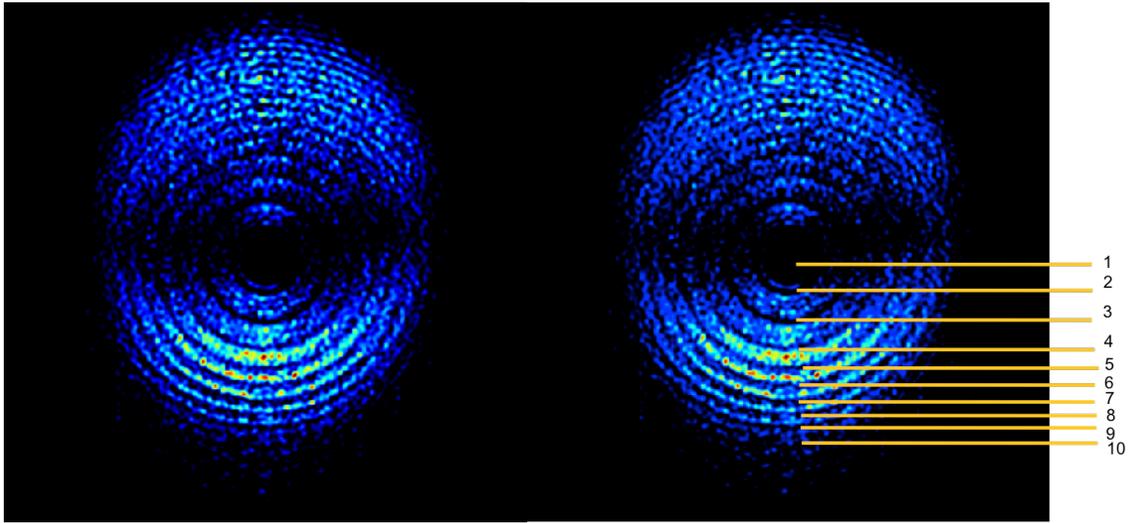


Fig 3.1.2 –Electron as Captured by Lund University (*wavelengths counted on image on right*)

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.

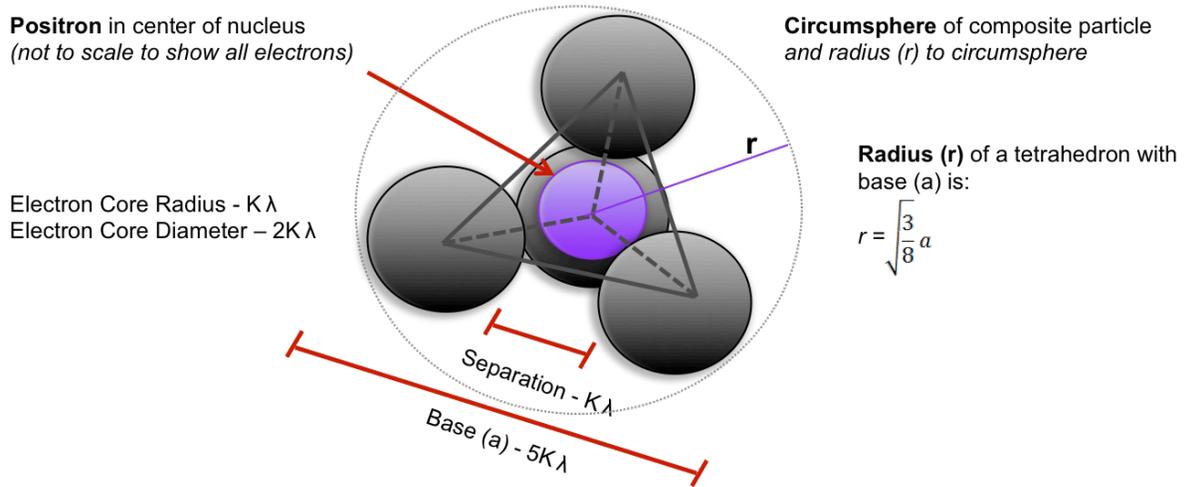


Fig 3.2.1 – Proton Proposed Model

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).¹⁰

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).

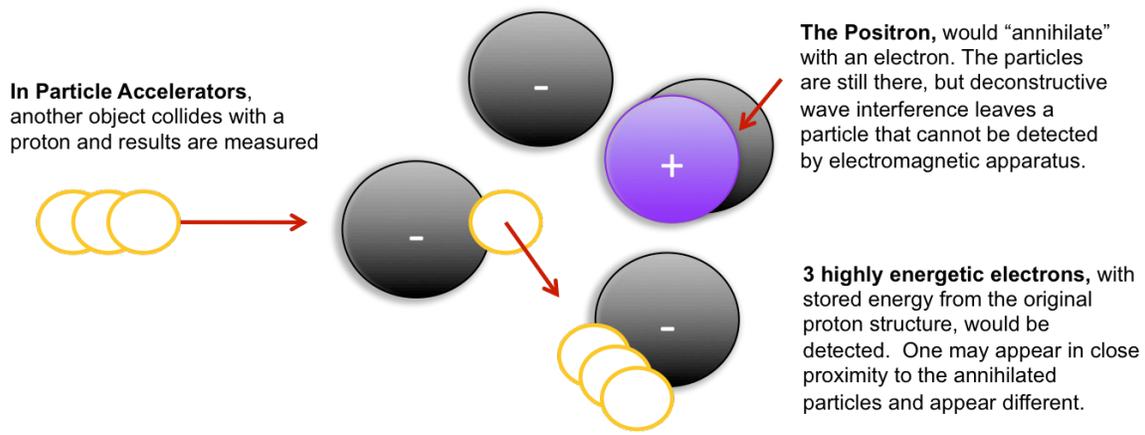


Fig 3.2.2 – Proton Collisions

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.

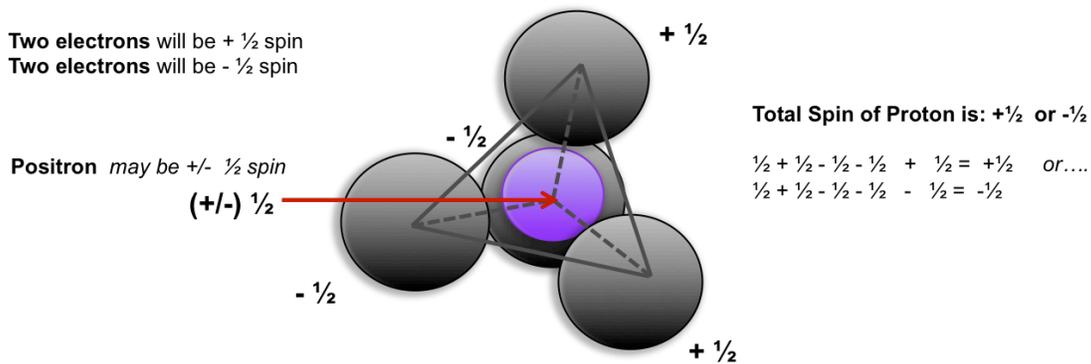


Fig 3.2.3 – Proton Spin

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, and twenty were derived by classical constants. In both cases, they can be derived from only five fundamental constants (excluding mathematical constants such as pi and Euler's number). In the case of wave constants, g-factors are used. 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 *Geometry of Spacetime*, *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 proportionality constants in force equations, that are no longer needed once their meaning is understood.

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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