Key Physics Equations and Experiments: Explained and Derived by Energy Wave Equations

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Summary

Three commonly used physics equations for energy are derived from a single equation that describes wave energy, linking the photon's quantum energy (E=hf) with mass-energy ($E=mc^2$) and energy-momentum (E=pc) found in particles. Then, the energy equation for particles is further derived in this paper to describe the Coulomb force ($F=kq_1q_2/r^2$) and the universal gravitational force ($F=Gm_1m_2/r^2$). All of these equations are ultimately derived from one fundamental energy wave equation.

This paper is a supplement to three papers that describe the energy, forces and constants in physics titled: 1) *Particle Energy and Interaction*[1], 2) *Forces*[2] and 3) *Fundamental Physical Constants*[3]. Those papers detail the assumptions and equations that are found here. In this paper, the key physics equations are linked together and explained how a single energy wave equation can be responsible for their derivations.

In addition, key experiments in physics that have led to confusion about the nature of particles or their medium are revisited with explanations from energy wave theory – some of which can be explained mathematically. The experiments discussed in this paper include: the Michelson-Morley experiment, neutrino oscillation and decay, photoelectric effect and the electron double slit experiment.

1. Notation, Constants and Principles of Energy Wave Theory

1.1. Energy Wave Equation Constants

Notation

The energy wave equations include notation to simplify variations of energies and wavelengths at different particle sizes (K) and wavelength counts (n), in addition to differentiating longitudinal and transverse waves.

Notation	Meaning
K_e	e – electron (wave center count)
λ_l λ_t	l – longitudinal wave, t – transverse wave
Δ_e Δ_{Ge} Δ_T	e – electron (orbital g-factor), Ge – gravity electron (spin g-factor), T – total (angular momentum g-factor)
F_g, F_m	g - gravitational force, m – magnetic force
$E_{(K)}$	Energy at particle with wave center count (K)

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, including a constant for the electron that is commonly used in this paper. Of particular note is that variable n, sometimes used for orbital sequence, has been renamed for particle shells at each wavelength from the particle core.

Symbol	Definition	Value (units)
	Wave Constants	
A_l	Amplitude (longitudinal)	$3.662796647 \times 10^{-10}$ (m)
λ_l	Wavelength (longitudinal)	$2.817940327 \times 10^{-17}$ (m)
ρ	Density (aether)	$9.422369691 \times 10^{-30}$ (kg/m^3)
c	Wave velocity (speed of light)	299,792,458 (m/s)
	Variables	
δ	Amplitude factor	variable - (m^3)
K	Particle wave center count	variable - *dimensionless*
n	Wavelength count	variable - *dimensionless*
Q	Particle count (in a group)	variable - *dimensionless*

Electron Constants		
K_e	Particle wave center count - electron	10 - *dimensionless*
Derived Constants*		
O_e	Outer shell multiplier – electron	2.138743820 – *dimensionless*
Δ_e / δ_e	Orbital g-factor /amp. factor electron	0.993630199 – *dimensionless* / (m^3)
Δ_{Ge}/δ_{Ge}	Spin g-factor/amp. gravity electron	0.982746784 – *dimensionless* / (m^3)
Δ_T	Total angular momentum g-factor	0.976461436 – *dimensionless*
α_e	Fine structure constant	0.007297353 – *dimensionless*
α_{Ge}	Gravity coupling constant - electron	2.400531449 x 10^{-43} - *dimensionless*

Table 1.1.2 – Energy Wave Equation Constants and Variables

* Refer to Appendix for derivation of the *Derived Constants*

1.2. Principles

The following are principles, and the mathematical equations that represent these principles, that will be used in the derivations of the key equations.

Key Principles and Equations

1. Wave energy is proportional to **amplitude**, **wavelength**, **wave speed** and **density** of a defined **volume**.

$$E = \rho V \left(\frac{c}{\lambda} A\right)^2 \tag{1.1}$$

2. Frequency is wave speed over wavelength, which governs time.

$$f = \frac{c}{\lambda} \tag{1.2}$$

3. Density and wave speed are constant for all equations – validated by calculations matching experiments taken from Earth. *It remains possible that these are not constant elsewhere in the universe.*

4. Wavelength and amplitude have initial (default) values but will change based on constructive/destructive waves.

5. Particles have wave centers (K) that reflect longitudinal waves, and therefore, when reflected, both amplitude and wavelength increase proportional to the number of wave centers (K). The radius from the center of the particle to the edge of its first wavelength, r_{core}, is based on K (Eq. 1.5.1). Particles create standing waves when reflected

that maintain form until n=K number of waves, where n is the wavelength count. This is K^2 times wavelength (Eq. 1.5.2) and it is the defining edge of the particle, $r_{particle}$. Beyond the particle's standing wave edge, waves are traveling in form. The distance, r, to any point in space can be calculated for this particle based on the number of wavelengths, n (Eq. 1.5.3).

$$r_{core} = K\lambda_l \tag{1.5.1}$$

$$r_{particle} = K^2\lambda_l \tag{1.5.2}$$

$$r = nK\lambda_l \tag{1.5.3}$$

6. The longitudinal wave volume of a particle's core is spherical for three-dimensional waves that reflect from wave centers.

$$V_l = \frac{4}{3}\pi r_l^3 \tag{1.6.1}$$

$$r_l = r_{core} \tag{1.6.2}$$

$$V_l = \frac{4}{3}\pi (K\lambda_l)^3 \tag{1.6.3}$$

7. The transverse wave volume for a photon is cylindrical. A particle vibrates to the particle radius ($r_{particle}$) creating a transverse wave in two directions opposite the vibration of the particle. The particle eventual settles into position and the vibration is short-lived, creating fixed ends of a cylinder.

$$V_t = \pi (r_t)^2 l_t \tag{1.7.1}$$

$$r_t = r_{particle} \tag{1.7.2}$$

$$l_t = r_{particle} \tag{1.7.3}$$

$$V_t = \pi (K^2\lambda_l)^3 \tag{1.7.4}$$

8. Energy can transition from longitudinal to transverse, and vice versa, but energy is always conserved. The ratio of volume between the particle and photon (V_{lt}) is important. Solving for V_l and V_t from above.

$$V_{lt} = \frac{V_l}{V_t} \tag{1.8.1}$$

$$V_{lt} = \frac{4}{3K^3} \tag{1.8.2}$$

9. Energy beyond a particle can also be measured. Longitudinal waves transition from standing waves to traveling waves at $r_{particle}$. The energy from the particle to any point is based on the ratio of standing wave distance to traveling wave distance (r).

$$E = E_{particle}\frac{r_{particle}}{r} \tag{1.9}$$

10. Particles move to minimize amplitude. An amplitude difference creates a force - the greater the amplitude difference the greater the force. Force is energy over distance (r). The amplitude between two groups of particles Q_1 and Q_2 determines the force. Q_1 and Q_2 are numerical counts of the number of particles separated by distance r. The impact of the force on Q_1 depends on the amplitude (which is based on number of Q_2 particles) and distance.

$$F = E_{particle}\frac{r_{particle}}{r}\left(\frac{Q_1Q_2}{r}\right) \tag{1.10}$$

11. Photon amplitude is more complicated than particle amplitude because it has transverse (A_t) and longitudinal (A_l) amplitude components. Multiple particles interacting causes constructive/destructive waves, causing a new amplitude. A new variable was created to signify this amplitude called the Amplitude Factor (units of m^3 for a three-dimensional wave) as it changes from longitudinal to transverse (hence the V_{lt} ratio in the equation). It is affected by half (2) since the longitudinal energy is transferred to two photons traveling in opposite directions.

$$\delta = \frac{A_tA_l^2}{2V_{lt}} \tag{1.11}$$

12. Photon wavelength is an adjustment from longitudinal amplitude (A_l) based on the new volume (V_{lt}) as it transitions from longitudinal to transverse (spherical to cylindrical). Amplitude is proportional to the number of wavelengths (n) from the atom's nucleus. This wavelength equation is used in *Particle Energy and Interaction* to accurately calculate hydrogen wavelengths and derive the Rydberg constant.

$$\lambda_t = A_lV_{lt}\frac{1}{\left(\frac{1}{n} - \frac{1}{n_0}\right)} \tag{1.12}$$

2. Deriving Key Equations

2.1. Energy and Force Relationships

The following sections describe the fundamental energy equations: mass-energy ($E=mc^2$), energy-momentum ($E=pc$) and photon energy ($E=hf$), and further describe the change in energy that causes the Coulomb force ($F=kq_1q_2/r^2$) and universal gravitational force ($F=Gm_1m_2/r^2$). By explaining these equations in terms of wave energy, they can be derived ultimately from one wave energy equation (Eq. 1.1). In addition, this section highlights how relativistic speeds affect mass, time and length. Relativity now has an explanation because it can also be derived from a wave equation due to the Doppler effect that has an effect on wavelength.

Figs. 5.1.1 and 5.1.2 illustrate a simple sine wave that describes:

- A particle at rest (no change in wavelength or amplitude). This will be proven to be mass-energy.
- A change in wavelength. This will be proven in energy-momentum and the wavelength change is the basis for relativity.
- A change in amplitude. This is the cause of force as particles move to minimize amplitude. The energy difference can be converted from longitudinal to transverse in particle vibration. This will be proven in photon energy.
- Two or more particles with zero amplitude. This is the cause of annihilation, when two particle longitudinal energies are completely transferred to transverse (photon) energy. Transverse energy (photons) can also be re-transferred back to the particle, creating the perception of "pair production" that a particle and its anti-particle are created out of a vacuum.

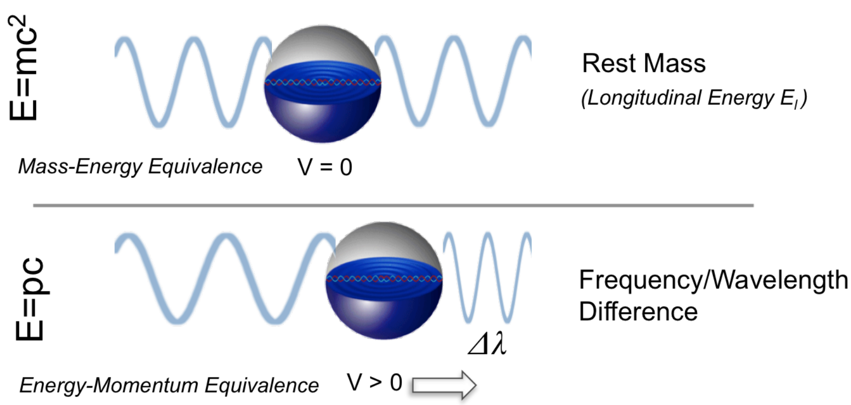

Fig 5.1.1 –Energy Relationship – Single Particle

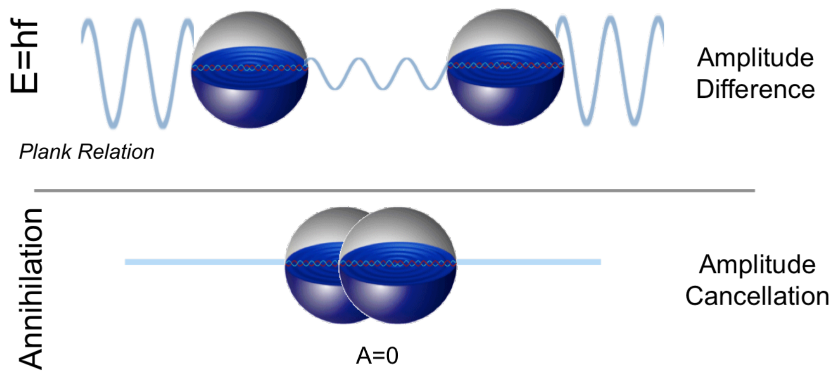

Fig 5.1.2 –Energy Relationship –Particle Interaction

2.2. Photon Energy (E=hf)

Photon energy, otherwise known as Planck's relation, is a result of a transverse wave from the vibration of a particle due to a difference in amplitude. This may happen during annihilation of a particle, or when a particle transitions between orbitals in an atom.

Wave energy equation from (Eq. 1.1)

$$E = \rho V \left(\frac{c}{\lambda} A\right)^2 \quad \textbf{(2.2.1)}$$

Photons are created from longitudinal particle vibration. Eq. 2.2.1 is rewritten to include the transverse component.

$$E_t = \rho V_t \frac{c}{\lambda_t} A_t \frac{c}{\lambda_l} A_l \left(\frac{A_{l_t}}{\lambda_l}\right) \quad \textbf{(2.2.2)}$$

From Eq. 1.11, amplitude is rewritten in terms of Amplitude Factor for the electron.

$$A_t A_l^2 = \delta_e 2 V_{lt} \quad \textbf{(2.2.3)}$$

Substitute 2.2.3 into 2.2.2.

$$E_t = \rho V_t \frac{c}{\lambda_t} \frac{c}{\lambda_l^2} \delta_e 2 V_{lt} \quad \textbf{(2.2.4)}$$

Substitute Eqs. 1.7.4 and 1.8.2 for V_t and V_{lt} respectively.

$$E_t = \rho \left(\pi \left(K^2 \lambda_l\right)^3\right) \frac{c}{\lambda_t} \frac{c}{\lambda_l^2} \delta_e 2 \left(\frac{4}{3K^3}\right) \quad \textbf{(2.2.5)}$$

Photon energy as related to transverse wavelength.

$$E_t = \frac{8}{3}\pi\rho K^3\lambda_l c^2\delta_e\frac{1}{\lambda_t} \tag{2.2.6}$$

Photon energy as related to transverse frequency. From Eq. 1.2, wave speed and wavelength replaced with frequency, f.

$$E_t = \frac{8}{3}\pi\rho K_e^3\lambda_l c\delta_e(f) \tag{2.2.7}$$

Planck constant (h) is based on the wave constants in 2.2.7.

$$h = \frac{8}{3}\pi\rho K_e^3\lambda_l c\delta_e \tag{2.2.8}$$

Replace Eq. 2.2.7 wave constants with Planck constant (h). E=hf.

$$E_t = hf \tag{2.2.9}$$

Proof: Solving for the wave constants in Eq. 2.2.8 for Planck constant yields the accurate numerical value and units. Units are kg m^2 / s.

$$h = \frac{8}{3}\pi\rho K_e^3\lambda_l c\delta_e = 6.6261\cdot10^{-34} \tag{2.2.10}$$

2.3. Mass-Energy Equivalence ($E=mc^2$)

Particle rest energy is the sum of standing wave energy. Spherical, longitudinal waves reflect off the particle's wave centers (K) to create standing waves until the particle's radius, which the waves break down to become traveling waves again. Standing wave energy is stored energy.

Wave energy equation from (Eq. 1.1)

$$E = \rho V\left(\frac{c}{\lambda}A\right)^2 \tag{2.3.1}$$

Eq. 2.3.1 is rewritten for three-dimensional in-waves and out-waves that create standing waves.

$$E_l = \rho V_l \left(\frac{c}{\lambda_l}\right)_{in} \left(\frac{A_l^3}{r^2}\right)_{in} \left(\frac{c}{\lambda_l}\right)_{out} \left(\frac{A_l^3}{r^2}\right)_{out} \qquad \textbf{(2.3.2)}$$

Substitute 1.6.1 spherical volume and simplify. In-wave and out-wave amplitude and wavelength are equal for standing waves.

$$E_l = \rho \left(\frac{4}{3}\pi r^3\right) \frac{c^2}{\lambda_l^2} \left(\frac{A_l^3}{r^2}\right)^2 \qquad \textbf{(2.3.3)}$$

Per the rule for Eq. 1.5.1, wavelength and amplitude are affected by the number of wave centers (K).

$$E_{core} = \rho \left(\frac{4}{3}\pi (K\lambda_l)^3\right) \frac{c^2}{\lambda_l^2} \left(\frac{(KA_l)^3}{(K\lambda_l)^2}\right)^2 \qquad \textbf{(2.3.4)}$$

Energy is a summation of each standing wave, from n=1 to K wave centers. At n=1, volume is spherical; at n>2, it is a spherical shell.

$$E_{l(K)} = \sum_{n=1}^{K} \rho \left(\frac{4}{3}\pi (n(K\lambda_l))^3 - \left(\frac{4}{3}\pi ((n-1)K\lambda_l)^3\right)\right) \frac{c^2}{\lambda_l^2} \left(\frac{(KA_l)^3}{(n(K\lambda_l))^2}\right)^2 \qquad \textbf{(2.3.5)}$$

Simplify Eq. 2.3.5.

$$E_{l(K)} = \frac{4\pi\rho K^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.3.6)}$$

Mass is stored (standing wave) energy. It is the wave constants in Eq. 2.3.6, where wave centers (K) is variable.

$$m_{(K)} = \frac{4\pi\rho K^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.3.7)}$$

Substitude mass (m) into 2.3.6 to replace constants. Only c^2 remains. $E=mc^2$.

$$E_l = mc^2 \quad \textbf{(2.3.8)}$$

Proof: Particle energies were calculated in *Particle Energy and Interaction*, in which the electron was found to have 10 wave centers (K). It matches in both numerical value and units. Units are kg.

$$m_{(10)} = \frac{4\pi\rho K^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} = 9.109 \cdot 10^{-31} \quad \textbf{(2.3.9)}$$

Outer Shell Multiplier (O): In Eq. 2.3.5, the particle energy is represented by the summation of energy at each spherical shell. After simplification in Eq. 2.3.6, the summation in the equation becomes a multiplier of the particle's core energy and is constant for each particle. The electron is the most common particle and a constant was given to make this equation more readable.

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(2.3.10)}$$

Electron Rest Energy (E_e): Eq. 2.3.6 is rewritten specific to the electron with K_e and O_e constants for readability. This will be used in the section on forces. Units are in joules.

$$E_e = E_{l(10)} = \frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} = 8.1871 \cdot 10^{-14} \quad \textbf{(2.3.11)}$$

2.4. Coulomb's Law ($F=kqq/r^2$)

Coulomb's Law is the main force that governs the motion of particles. The other forces, including gravity, are derived from this force but differ in amplitude as shown in the *Forces* paper. It is the main force, meaning that each particle has a standard amplitude, and this amplitude increases proportional to the number of particles in each group (Q) that are measured at a distance (r). The equation to derive force also comes from the energy equation.

Force equation from Eq. 1.10

$$F = E_{particle} \frac{r_{particle}}{r} \left(\frac{Q_1 Q_2}{r} \right) \tag{2.4.1}$$

Force equation for the electron particle. Substitute Eq. 2.3.11 for E and substitute Eq. 1.5.2 for $r_{particle}$.

$$F = \frac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3} c^2 \, (K_e^2 \lambda_l) \, \frac{Q_1 Q_2}{r^2} \tag{2.4.2}$$

Eq. 2.4.2 simplified. This is the Force Equation used in the *Forces* paper.

$$F = \frac{4\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} \frac{Q_1 Q_2}{r^2} \tag{2.4.3}$$

Coulomb's law uses electron charge (q). The Force equation uses a dimensionless particle count (Q), so it needs to be substituted. The relationship is based on count Q times elementary charge (e).

$$q = Qe \tag{2.4.4}$$

Elementary charge (e) is complex, but it was derived in *Fundamental Physical Constants*. Value and units match (see end of section).

$$e = \frac{A_l^4}{2K_e^6} \sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e} \right)} \cdot (\varDelta_T^{-1}) \tag{2.4.5}$$

Replace 2.4.5 into 2.4.4 and solve for Q.

$$Q = \frac{q}{\frac{A_l^4}{2K_e^6} \sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e} \right)} \cdot (\varDelta_T^{-1})} \tag{2.4.6}$$

Use Q_1 and Q_2 from Eq. 2.4.6 to substitute into 2.4.3.

$$F = \frac{4\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} \left(\frac{q_1}{\frac{A_l^4}{2K_e^6} \sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e} \right)} \cdot (\varDelta_T^{-1})} \right) \left(\frac{q_2}{\frac{A_l^4}{2K_e^6} \sqrt{\left(\frac{\pi O_e}{\lambda_l^3 \delta_e} \right)} \cdot (\varDelta_T^{-1})} \right) \frac{1}{r^2} \tag{2.4.7}$$

Simplify Eq. 2.4.7.

$$F = \frac{16\rho K_e^{19}\lambda_l c^2\delta_e}{3A_l^2}(\Delta_T^2)\frac{q_1 q_2}{r^2} \quad \textbf{(2.4.8)}$$

Other than charges q_1 and q_2 and distance r, all of the remaining are constant. This becomes Coulomb's constant (k).

$$k = \frac{16\rho K_e^{19}\lambda_l c^2\delta_e}{3A_l^2}(\Delta_T^2) \quad \textbf{(2.4.9)}$$

Substitute k for wave constants found in Eq. 2.4.8.

$$F = k\frac{q_1 q_2}{r^2} \quad \textbf{(2.4.10)}$$

Proof: Coulomb's constant was calculated in *Forces*. It matches in numerical value. In wave theory, Coulombs (C) is measured in amplitude (meters). Units in Eq. 2.4.11 resolve to kg m/s^2. Coulomb's constant units are kg m^3 / s^2 C^2. When Coulomb charge is replaced by meters, this resolves correctly to kg m/s^2.

$$k = \frac{16\rho K_e^{19}\lambda_l c^2\delta_e}{3A_l^2}(\Delta_T^2) = 8.988\cdot 10^9 \quad \textbf{(2.4.11)}$$

Proof: Elementary charge was derived in *Fundamental Constants*. It matches in numerical value. Similar to above, units are in Coulombs (C). When replaced by meters (units for charge in wave theory), then units resolve correctly. Units in Eq. 2.4.12 is meters.

$$e = \frac{A_l^4}{2K_e^6}\sqrt{\left(\frac{\pi O_e}{\lambda_l^3\delta_e}\right)}\cdot(\Delta_T^{-1}) = 1.602\cdot 10^{-19} \quad \textbf{(2.4.12)}$$

2.5. Universal Gravitation (F=Gmm/r^2)

Similar to Coulomb's Law (Section 2.4), the equation for Universal Gravitation is also originally derived from the energy equation. The structure of the force equation for gravitation is similar to Coulomb's Law with the exception that it has a dimensionless coupling constant that represents the reduction in wave amplitude (energy) which is shown in Eq. 2.5.2. As a particle spins, it loses longitudinal energy which is converted to transverse (magnetic). Although the longitudinal amplitude loss is slight, when a large number of particles are together in a large body such as a planet, the effect becomes much greater. This creates a shading effect where amplitude is higher before a wave passes through a large body and lower after it passes through it. Other particles in the vicinity are attracted to the large body because they move to minimize amplitude. Refer to the *Forces* paper for additional explanations and calculations of gravity.

Force equation from Eq. 1.10.

$$F = E_{particle} \frac{r_{particle}}{r} \left(\frac{Q_1 Q_2}{r} \right) \quad \textbf{(2.5.1)}$$

Particle energy is mc^2 with reduced amplitude (see 2.5.3 for explanation of the Gravity coupling constant). Substitute 1.5.2 for particle radius.

$$F = (m_e c^2 \alpha_{Ge})\ (K_e^2 \lambda_l)\ \frac{Q_1 Q_2}{r^2} \quad \textbf{(2.5.2)}$$

Gravity coupling constant for the electron is a $2.4*10^{-43}$ reduction in amplitude due to particle spin. It is found in the *Forces* paper. This is the relative strength ratio of electromagnetism vs gravity for the electron.

$$\alpha_{Ge} = \frac{\frac{1}{2} \left(\frac{\lambda_l}{K_e^4 A_l} \right)^4}{\alpha_e} \quad \textbf{(2.5.3)}$$

In Eq. 2.5.3, the fine structure constant is a part of the gravity coupling constant. There are a few ways to derive this constant in *Fundamental Physical Constants*. Eq. 2.5.4 is one way. The inverse value of this constant is 137.036.

$$\frac{1}{\alpha_e} = \frac{4}{3} K_e \delta_e \frac{\rho}{m_e} \quad \textbf{(2.5.4)}$$

Substitute 2.5.4 into 2.5.3.

$$\alpha_{Ge} = \frac{1}{2} \left(\frac{\lambda_l}{K_e^4 A_l} \right)^4 \frac{4}{3} K_e \delta_e \frac{\rho}{m_e} \quad \textbf{(2.5.5)}$$

Substitute 2.5.5 into 2.5.2.

$$F = m_e c^2 \left(\frac{1}{2} \frac{\lambda_l^4}{A_l^4 K_e^{16}} \frac{4}{3} K_e \delta_e \frac{\rho}{m_e} \right) (K_e^2 \lambda_l)\ \frac{Q_1 Q_2}{r^2} \quad \textbf{(2.5.6)}$$

Universal gravitation uses mass, not particle count (Q). To get total mass (m_1), it is particle count (Q_1) times electron mass (m_e). Same for m_2.

$$m_1 = Q_1 m_e \tag{2.5.7}$$

Solve for Q_1 (Q_2 is the same) using Eq. 2.5.7 then substitute into 2.5.6.

$$F = m_e c^2 \left(\frac{1}{2} \frac{\lambda_l^4}{A_l^4 K_e^{16}} \frac{4}{3} K_e \delta_e \frac{\rho}{m_e} \right) (K_e^2 \lambda_l) \frac{m_1}{m_e} \frac{m_2}{m_e} \frac{1}{r^2} \tag{2.5.8}$$

Simplify 2.5.8.

$$F = \frac{2\rho\lambda_l^5 c^2 \delta_e}{3K_e^{13} A_l^4} \frac{m_1}{m_e} \frac{m_2}{m_e} \frac{1}{r^2} \tag{2.5.9}$$

The two electron masses (m_e) can be substituted with Eq 2.3.9 (using Oe instead of summation for readability).

$$F = \frac{2\rho\lambda_l^5 c^2 \delta_e}{3K_e^{13} A_l^4} \frac{1}{\left(\frac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3} \right)^2} \frac{m_1 m_2}{r^2} \tag{2.5.10}$$

Simplify Eq. 2.5.10.

$$F = \frac{3\lambda_l^{11} c^2 \delta_e}{8\pi^2 \rho K_e^{23} A_l^{16} O_e^2} \frac{m_1 m_2}{r^2} \tag{2.5.11}$$

Other than mass (m_1 and m_2) and distance (r), the remaining are constants. It can be replaced with G.

$$G = \frac{3\lambda_l^{11} c^2 \delta_e}{8\pi^2 \rho K_e^{23} A_l^{16} O_e^2} \tag{2.5.12}$$

Substitute 2.5.12 into 2.5.11.

$$F = G \frac{m_1 m_2}{r^2} \tag{2.5.13}$$

Proof: The Gravitational constant was calculated in *Forces*. It matches in numerical value and in units. Units are $m^3 / s^2\ kg$.

$$G = \frac{3\lambda_l^{11} c^2 \delta_e}{8\pi^2 \rho K_e^{23} A_l^{16} O_e^2} = 6.674 \cdot 10^{-11} \qquad \textbf{(2.5.11)}$$

2.6. Newton's Second Law (F=ma)

Newton's Second Law, where force is a function of mass and acceleration is relatively simple to derive, but harder to prove. The force equation is based on Coulomb's law which is used for the force of particles. Given the nature of electrons, it can be difficult to measure acceleration and distances, required for the proof for this equation. However, acceleration due to gravitation is well known and thus the proof for Newton's Second Law comes from the derivation of the gravitational force (Section 2.5). The acceleration due to surface gravity was calculated using Eq. 2.6.3 for the planets in the solar system in the *Forces* paper.

Force equation from Eq. 1.10.

$$F = E_{particle} \frac{r_{particle}}{r} \left(\frac{Q_1 Q_2}{r} \right) \qquad \textbf{(2.6.1)}$$

Particle energy is mc^2. Substitute 1.5.2 for particle radius.

$$F = (mc^2)\,(K_e^2 \lambda_l)\,\frac{Q_1 Q_2}{r^2} \qquad \textbf{(2.6.2)}$$

Acceleration is the rate at which the particle core (wave centers) move toward the particle center or edge. Its rate depends on amplitude difference, which as factor of particle counts (Q_1 and Q_2). See below for proof.

$$a = c^2\,(K_e^2 \lambda_l)\,\frac{Q_1 Q_2}{r^2} \qquad \textbf{(2.6.3)}$$

Replace variables in 2.6.2 with acceleration (a) found in 2.6.3.

$$F = ma \qquad \textbf{(2.6.4)}$$

Proof: Acceleration values were calculated in *Forces* for various planet surface gravity/acceleration values, including Earth which was found to be 9.81 m / s^2. The calculations require an explanation for obtaining particle count (Q) based on estimated nucleons for planets, not covered here. Acceleration units are correct in Eq. 2.6.3 as m / s^2.

2.7. Energy-Momentum (E=pc)

This section begins to introduce relativistic speeds and how it affects particles as momentum (p) is mass (m) times velocity (v). Velocity changes the frequency/wavelength of a particle in motion. A particle sees a higher frequency on its leading edge (direction of motion) than the trailing edge. The change in frequency and thus wavelength is only in the direction of motion.

To an observer, the particle experiences the Doppler effect and thus Doppler equations are used to find the leading edge and trailing (lag) frequencies. The particle's frequency while in motion is the geometric mean of the lead and lag frequencies. The Lorentz Factor then becomes apparent and is derived naturally in this section from particle energy.

Energy-momentum requires the addition of the particle velocity (v) into the energy equation, which is found in the complete form of the Longitudinal Energy Equation found in *Particle Energy and Interaction.* The in-wave energy and out-wave energy of a particle with velocity is found in Eqs 2.7.1 and 2.7.2.

$$E_{l\,(in)} = \frac{1}{2}\rho\left(\frac{4}{3}\pi\,(K_e\lambda_l)^3\right)\left(\frac{c}{\lambda_l\sqrt{\left(1+\frac{v}{c}\right)}}\frac{(K_eA_l)^3}{(K_e\lambda_l)^2}\right)\left(\frac{c}{\lambda_l\sqrt{\left(1-\frac{v}{c}\right)}}\frac{(K_eA_l)^3}{(K_e\lambda_l)^2}\right) \quad \textbf{(2.7.1)}$$

$$E_{l\,(out)} = \frac{1}{2}\rho\left(\frac{4}{3}\pi\,(K_e\lambda_l)^3\right)\left(\frac{c}{\lambda_l\sqrt{\left(1+\frac{v}{c}\right)}}\frac{(K_eA_l)^2K_e\,(A_l-A_l\sqrt{\alpha_{Ge}})}{(K_e\lambda_l)^2}\right)\left(\frac{c}{\lambda_l\sqrt{\left(1-\frac{v}{c}\right)}}\frac{(K_eA_l)^2K_e\,(A_l+A_l\sqrt{\alpha_{Ge}})}{(K_e\lambda_l)^2}\right) \quad \textbf{(2.7.2)}$$

The gravitational coupling constant (α_{Ge}) is negligible (2.4 x 10^{-43}), so it can be ignored for the purpose of this derivation. The energy is the combination of the in-wave and out-wave.

Particle energy is the combination of Eqs. 2.7.1 and 2.7.2

$$E = E_{l\,(in)} + E_{l\,(out)} \quad \textbf{(2.7.3)}$$

Subtituting Eqs. 2.7.1 and 2.7.2 into 2.7.3 and solving (assuming negligble α_{Ge})

$$E = \frac{4\pi\rho K_e^5A_l^6c^2}{3\lambda_l^3\sqrt{1+\frac{v}{c}}\cdot\sqrt{1-\frac{v}{c}}} \quad \textbf{(2.7.4)}$$

Simpifying the square roots in the demonimator

$$E = \frac{4\pi\rho K_e^5A_l^6c^2}{3\lambda_l^3}\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \quad \textbf{(2.7.5)}$$

Lorentz factor is seen in Eq. 2.7.5.

$$\gamma = \frac{1}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \tag{2.7.6}$$

From Eq. 2.3.9, rest mass of electron when K=10 (K_e)

$$m_0 = \frac{4\pi\rho K_e^5 A_l^6}{3\lambda_l^3} \tag{2.7.7}$$

Subtitute Eq. 2.7.7 into 2.7.5

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2.7.8}$$

Square both sides to remove the square root

$$E^2 = \frac{m_0^2 c^4}{1 - \frac{v^2}{c^2}} \tag{2.7.9}$$

Replace E^2 with m^2c^4 (square of E).

$$m^2 c^4 = \frac{m_0^2 c^4}{1 - \frac{v^2}{c^2}} \tag{2.7.10}$$

$$m^2 c^4 \left(1 - \frac{v^2}{c^2}\right) = m_0^2 c^4 \tag{2.7.11}$$

$$m^2 c^4 - \frac{m^2 v^2 c^4}{c^2} = m_0^2 c^4 \tag{2.7.12}$$

Rearrange to isolate “mv”

$$m^2 c^4 - (mv)^2 c^2 = m_0^2 c^4 \tag{2.7.13}$$

Momentum (p) is mass times velocity (v)

$$p = mv \tag{2.7.14}$$

Subtitute Eq. 2.7.14 into 2.7.13

$$m^2c^4 - p^2c^2 = m_0^2c^4 \tag{2.7.15}$$

$$E^2 - p^2c^2 = m_0^2c^4 \tag{2.7.16}$$

Complete energy-momentum equation.

$$E^2 = (m_0c^2)^2 + (pc)^2 \tag{2.7.17}$$

E=pc when rest mass not considered from Eq. 2.7.17.

$$E = pc \tag{2.7.18}$$

2.8. Relativity

Einstein's work on Special Relativity and General Relativity laid the foundation of physics over the past century but has left as many questions as to why these equations work. For example, why does the length of an object contract with motion? Why does mass increase in size?

In this section, the major theories suggested by Einstein are derived and explained with an energy wave equation.

Relative Energy and Mass

In section 2.7, the energy-momentum relation was explained and velocity is introduced into the equation to calculate the frequency difference when a particle is in motion. To recap, because of motion, the wave experiences the Doppler effect and the new frequency is the geometric mean of the leading and trailing frequencies in the direction of motion.

At low velocities, the frequency difference is negligible. However, at relativistic speeds closer to the speed of light, this difference needs to be considered in calculations. This is the Lorentz factor as derived in Eq. 2.7.6 as relative to the initial wavelength.

From Eq. 2.7.8

$$E = \frac{m_0c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2.8.1}$$

Lorentz factor from Eq. 2.7.7

$$\gamma = \frac{1}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(2.8.2)}$$

Substitute Eq. 2.8.2 into Eq. 2.8.1. **Relative energy.**

$$E = \gamma m_0 c^2 \quad \textbf{(2.8.3)}$$

Rearrange Eq. 2.8.3

$$\frac{E}{c^2} = \gamma m_0 \quad \textbf{(2.8.4)}$$

Mass is energy without consideration of wave speed.

$$m = \frac{E}{c^2} \quad \textbf{(2.8.5)}$$

Subtitute Eq. 2.8.5 into 2.8.4. **Relative mass.**

$$m = \gamma m_0 \quad \textbf{(2.8.6)}$$

Time Dilation

Time may be thought of as the frequency of the universal waves that travel the aether, responsible for in-waves within particles. Note that frequency is measured in Hertz, or cycles per second. This reintroduces the concept of a universal time, but time is relative to an observer (consistent with Einstein's view) based on a particle's movement. Time is relative due to a change in frequency of a particle or collection of particles, as seen by an observer. As the particle moves, it affects its frequency and how an instrument can measure the frequency cycle of a moving object.

The following starts with the wavelength change for a particle in motion and derives the time dilation equation.[4]

From Eq. 2.7.1 the change in the wavelength related to velocity

$$\Delta\lambda_x = \lambda_l \sqrt{1 - \frac{v^2}{c^2}} \quad \textbf{(2.8.7)}$$

Replace demoninator with Lorentz factor

$$\Delta\lambda_x = \frac{\lambda_l}{\gamma} \quad \textbf{(2.8.8)}$$

The fundamental frequency is found in Eq. 2.7.1 for a given direction.

$$f_0 = \frac{c}{\lambda_l} \tag{2.8.9}$$

A change in frequency based on a change in wavelength

$$\Delta f_x = \frac{c}{\Delta\lambda_x} \tag{2.8.10}$$

Subtitute Eq. 2.8.8 into 2.8.10

$$\Delta f_x = \frac{\gamma c}{\lambda_l} \tag{2.8.11}$$

Substitute Eq. 2.8.9 into 2.8.11.

$$\Delta f_x = \gamma f_0 \tag{2.8.12}$$

Time is frequency. Replace frequency with time (t).

$$\Delta t_x = \gamma t_0 \tag{2.8.13}$$

Time dilation.

Length Contraction

When an object is in motion, it contracts in the direction of travel. As with other relativity equations, it is negligible at low velocities but the size of an object will shrink considerably in the axis of motion at relativistic speeds. Why?

The object that contracts is a collection of atoms, bound together by sharing electrons. When atoms that make up the structure are in motion, its frequency changes (Doppler effect), and wavelength becomes shorter. For a single atom, this means its electrons in its orbitals are drawn in closer. Orbitals are gaps created by wave cancellation, and with shorter wavelengths, these orbitals are closer to the nucleus. For example, the hydrogen 1s orbital was calculated as 187,789 wavelengths from the particle core in *Particle Energy and Interaction*. When in motion, its electron will still be 187,789 wavelengths from the particle core, but with shorter wavelengths, it will be physically closer to the nucleus as illustrated in Fig 2.8.1.

Since atoms share electrons, each atom in the direction of motion equally contracts such that the length is shorter relative to its initial length at the standard frequency/wavelength seen when the atom is at rest. Eq. 2.8.12 describes the length of the object as being the sum of the atoms and their wavelengths to its orbitals. The derivation of length contraction starts with the frequency change from time dilation, Eq. 2.8.8, and the following derivation concludes with a length contraction equation that matches Einstein's relativity.[5]

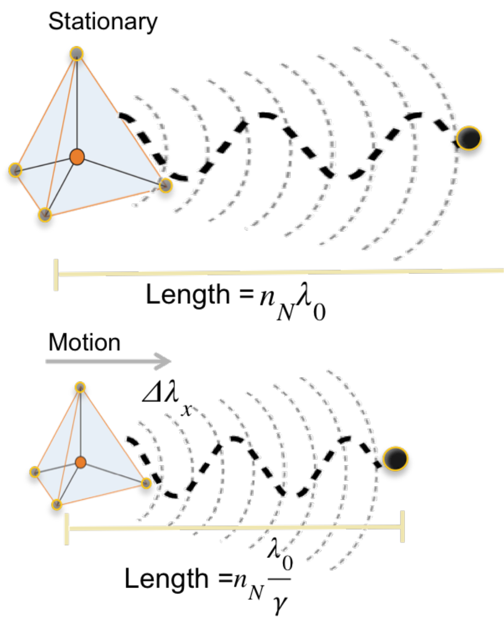

Fig 2.8.1 –Length Contraction

From Eq. 2.8.8

$$\Delta\lambda_x = \frac{\lambda_0}{\gamma} \tag{2.8.14}$$

Length is the sum of the distances between atoms

$$L_o = \sum n_N \lambda_0 \tag{2.8.15}$$

Length changes because wavelength contracts in X direction

$$\Delta L_x = \sum n_N \Delta\lambda_x \tag{2.8.16}$$

Subtitute Eq 2.8.14 into 2.8.16

$$\Delta L_x = \sum n_N \frac{\lambda_0}{\gamma} \tag{2.8.17}$$

Subtitute Eq. 2.8.15 into 2.8.17. **Length Contraction.**

$$\Delta L_x = \frac{L_o}{\gamma} \tag{2.8.18}$$

3. Key Experiments Explained

3.1. Michelson-Morley Aether Experiment Explained

The aether was commonly accepted in science until the Michelson-Morley experiment failed to detect the aether wind in an experiment in 1887. Numerous experiments following Michelson-Morley, with greater precision instruments, have also been unable to detect the aether. The aether is a critical, missing component of physics that must be considered to explain the wave nature of matter. Energy wave theory relies on the existence of the aether and must explain the results of the Michelson-Morley experiment.

A few years after the Michelson-Morley experiments were published, **Hendrik Lorentz suggested the experiment apparatus failed to consider length contraction in the direction of motion**.[6] Lorentz would later have the Lorentz contraction factor named after him, and matter has been proven to contract. In fact, Albert Einstein later used the Lorentz factor in relativity. However, Lorentz's explanation was disregarded as the reason the aether was not detected in the Michelson-Morley experiment.

Gabriel LaFreniere wrote a computer simulation of the Michelson-Morley experiment with and without the Lorentz factor built into the simulation.[7] With the Lorentz factor considered, the results are what Michelson and Morley expected, which shows a phase shift in the light wave – that the aether does exist. Without this factor considered, the results are what the Michelson-Morley experiment recorded, and why the aether was disregarded.

Fig. 3.1 shows a still image of the computer simulation written by LaFreniere. On the left is the expected result of a phase shift using the Michelson interferometer, which is the apparatus used to detect the aether. On the right is the actual result, which showed no phase shift, because one of the branches of the interferometer experienced length contraction (the branch in the direction of motion). The details of the experiment, including LaFreniere's explanation and the animated view of the computer simulation are available at:

http://www.rhythmodynamics.com/Gabriel_LaFreniere/sa_Michelson.htm.

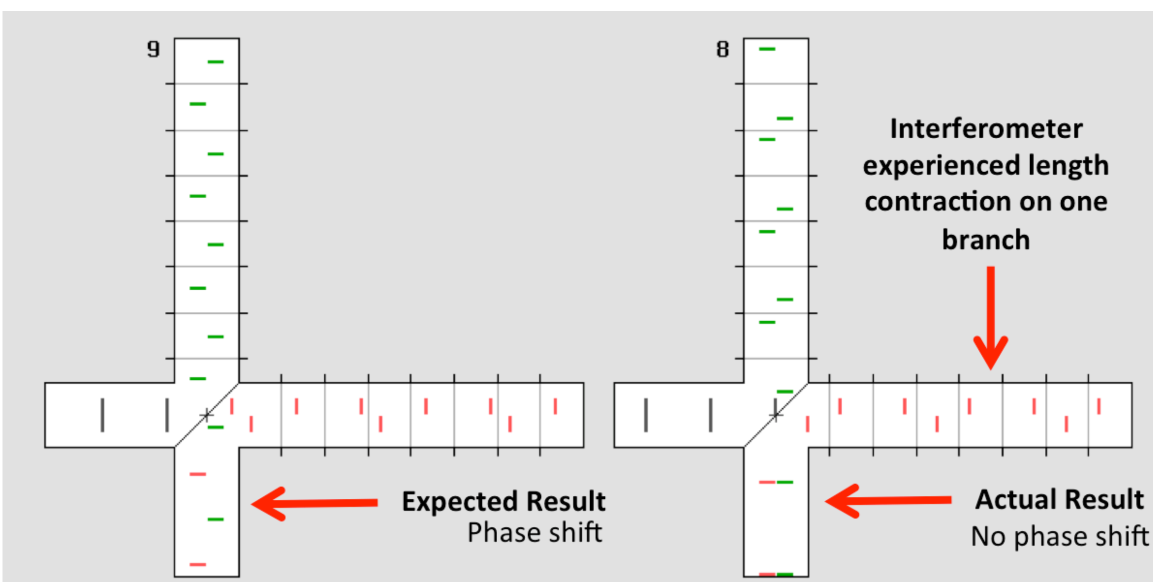

Fig 3.1 – Michelson Interferometer

3.2. Oscillation and Decay Explained

The three neutrinos (neutrino, muon neutrino and tau neutrino) are known to oscillate, meaning they can change into each other, becoming larger in mass or smaller in mass.[8] Meanwhile, many other particles are known to decay into particles of smaller mass. This can be explained by a fundamental particle that is the basic building block of energy that causes the formation of these particles. In the energy wave equation solution, this fundamental building block is a wave center (K), which was shown to have properties matching the neutrino.

In *Particle Energy and Interaction*, the three neutrinos were calculated with a wave center count of K=1, K=8 and K=20 for the neutrino, muon neutrino and tau neutrino respectively. The numbers 2, 8 and 20 are the first three magic numbers for atomic elements where there is more stability noted in elements. At these lower values of K, the energy level required to force wave centers together in these stable arrangements is quite possible in nature – on Earth. Solar neutrinos (K=1) generated by the Sun may combine on their way to Earth. It would require 8 neutrinos to combine to create the muon neutrino (K=8).

Larger particles would experience decay – the opposite of wave centers combining to create new particles. With decay, particles with wave centers that are not in stable formation would break apart into smaller particles. For example, the tau electron at K=50 wave centers would have multiple possibilities to decay as it has a large number of wave centers. Particles may not be stable due to each wave center attempting to be on the node of the wave.

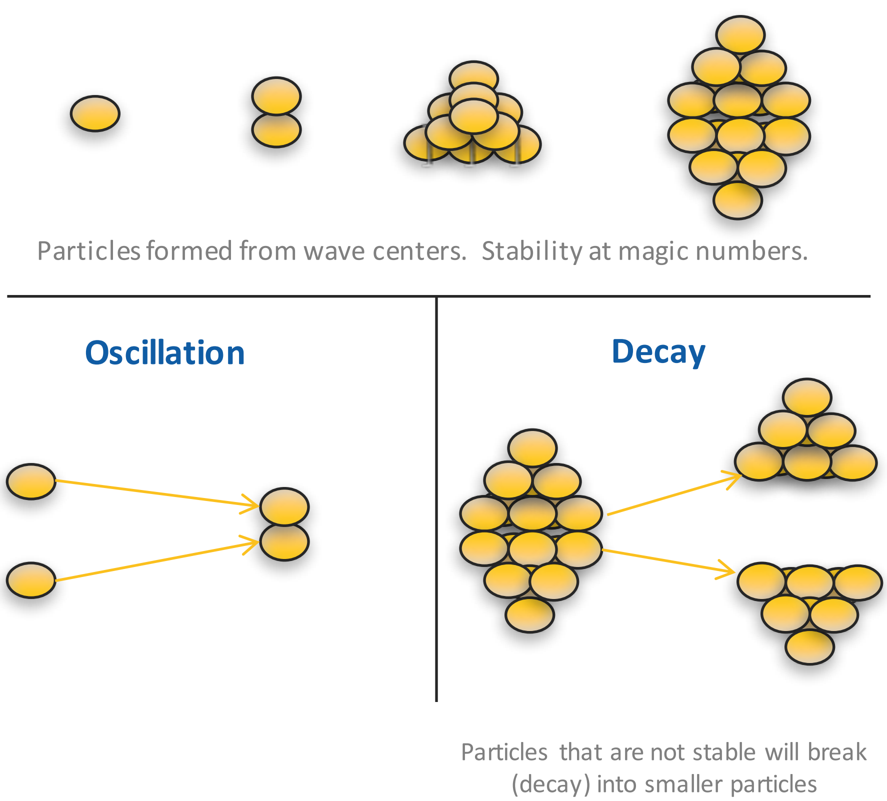

Fig 3.2 – Particle Creation – Oscillation and Decay

3.3. Photoelectric Effect Explained

In 1887, Heinrich Hertz was the first to observe the photoelectric effect that, amongst other observations of the subatomic world, led to the quantum revolution. Hertz witnessed electrons that were ejected from a metal when light was shone on it.[9] The interesting find that led to quantum physics, and a separation from classical physics, is that the ability to eject the electron is based on the wavelength of the light. Neither the length of time that the light is shone, nor the intensity, determines if the electron is ejected, or determines its kinetic energy once ejected.

For example, a red light shone on a metal surface might not eject an electron. A green light, with a shorter wavelength, might eject the electron. Whereas a blue light, with even shorter wavelength, might eject the electron with greater kinetic energy (velocity) than the green light. The red light could be shone for hours, much brighter than the blue light, and the results would be the same.

In 1905, Albert Einstein recognized that time and intensity were irrelevant in the experiment because light is "quantized" into packets. If light was a wave, it was expected prior to Einstein's paper that it would be a continuous wave. Einstein proved it differently.

A photon is a transfer of longitudinal wave energy to transverse wave energy. It has a fixed amplitude based on the electron's classical radius (Eq. 1.5.2), a variable transverse wavelength that is proportional the longitudinal amplitude being transferred and a volume that is cylindrical as explained in Eq. 1.7.1. It does **not have mass** as mass is defined as stored energy in standing waves. It is **not a particle**, as particles in wave theory are defined by a formation of wave centers that create standing waves. Rather, it is a transverse wave that is created by a vibrating particle. The vibration is finite, leading to a defined volume for the wave, otherwise known as a photon. Fig. 3.3 illustrates the packet of energy that strikes the electron, transferring transverse energy to longitudinal, thereby increasing amplitude between the nucleus and forcing the electron away from the atom.

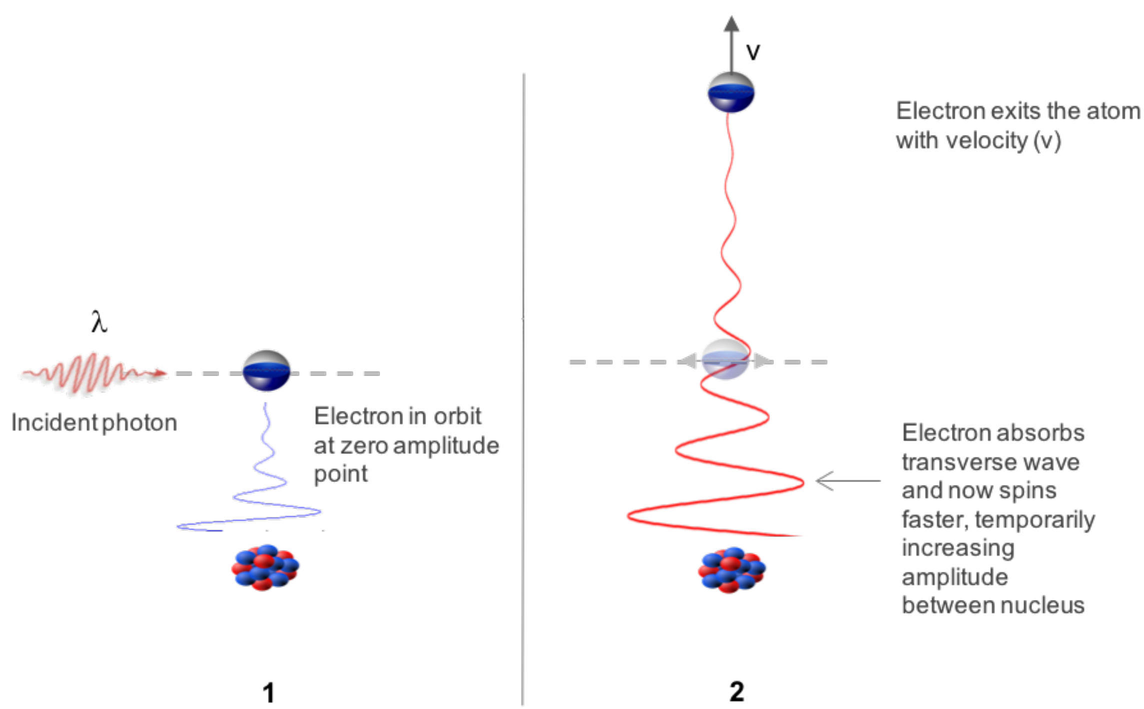

Fig 3.3 – Electron Path – Creating a Transverse Wave

The equations for transverse energy and wavelength contain an initial and final position for a particle that experiences a change in amplitude, which causes motion. However, it does not move from point A to point B like a man walking from his car into his home. Instead, a better analogy is a spring with a marble attached to the end. Stretch the spring and release it and the marble will move back-and-forth as the spring finds its equilibrium. As the electron changes orbits, it overshoots its final position, returns back (and overshoots again), and continues to repeat the process until it reaches equilibrium. This is the electron's path in Fig. 3.3.

Light is indeed a wave. It has a transverse component and a longitudinal traveling wave in a cylindrical shape. Einstein was also correct and it is a packet, or photon. In fact, two photons are generated, traveling in opposite directions from the vibrating particle.

3.4. Double Slit Experiment Explained

One of the experiments that led to the acceptance of wave-particle duality is the double slit experiment. Wave-particle duality is the confusing explanation that particles, including light, can be expressed not only in terms of being a particle but also a wave.[10] Conveniently, a quantum object can sometimes exhibit particle behavior and sometimes wave behavior.

The double slit experiment first showed this property for light. In the experiment, light is shone through a slit in the first object such that it can proceed through to a second object. It can be done with a simple flashlight, a piece of paper with one hole/slit cut into it, and a wall behind it. The light captured on the wall will match the slit pattern in the paper. However, if a second slit is cut in the paper, it shows a diffraction pattern, because of wave interference from the light passing through both slits.

The double slit experiment first showed that light had both properties of a wave and a particle. However, as explained in Section 3.3, light does travel in packets – it is not a continuous wave - although it carries transverse and longitudinal traveling wave components. It is quantized.

The double slit experiment was also conducted on particles, like the electron, and similar results were obtained. The electron, thought to be a particle, also produced the same diffraction pattern. The electron and other elementary particles are currently also considered to have wave and particle characteristics - wave-particle duality. When one slit is open, the electron behaves like a particle. When the second slit is open, the electron produces a diffraction pattern, resembling a wave pattern. And if a measuring device is placed on the second slit to determine if the electron passes through the slit, it reverts back to the same result as one slit being open – no diffraction pattern is found.

An illustration to provide this explanation is shown in Fig. 3.4. Particles consist of wave centers that can be measured to have a definitive position in space and time. These same particles, such as the electron, also generate standing waves of energy and beyond the particle's radius, longitudinal traveling waves. This was modeled in the *Particle Energy and Interaction*. It's better to think of the electron as a particle, but one that reflects a wave and is affected by wave amplitudes of all particles, including itself, if it interacts with its own wave that has traveled through a second slit. The path of the electron being affected by its own traveling waves is illustrated in Fig. 3.4. Note the electron does not go through both slits. It is a particle and can only go through one slit.

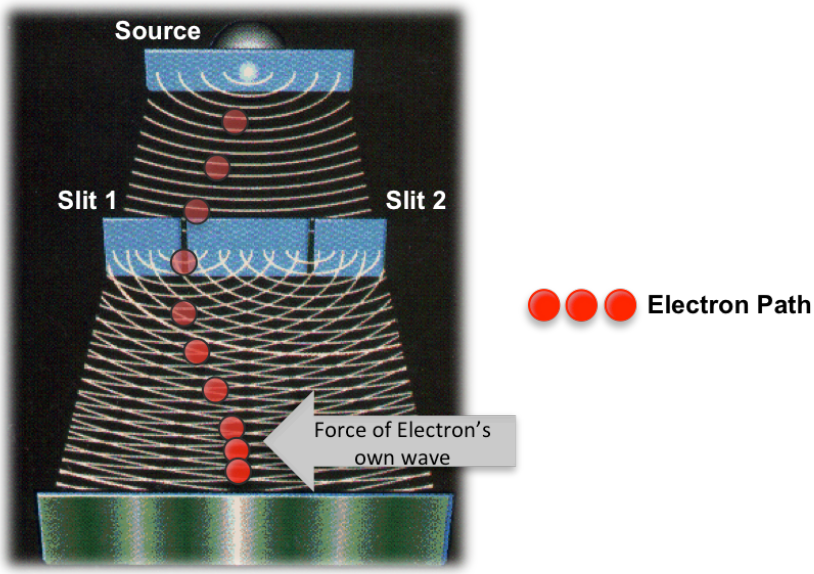

Fig 3.4 – Double Slit Experiment

If a measuring device is placed on one of the slits, it has the potential to affect the traveling wave generated by the electron. Cancelling or disrupting this wave causes the change in the motion of the electron. If its traveling waves through the second slit are cancelled with destructive wave interference, then the electron would have a motion similar to the single slit experiment.

Light is a wave, but travels in a discrete packet known as the photon.

The electron is a particle as it contains wave centers that reflect in-waves to out-waves, thereby creating standing waves of energy. Beyond the particle's definition (radius), its out-waves are longitudinal traveling waves.

Appendix

Derived Constants: The derivations for the constants are:

The outer shell multiplier for the electron is a constant for readability, removing the summation from energy and force equations since it is constant for the electron. It is the addition of spherical wave amplitude for each wavelength shell (n).

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(A.1)}$$

The three modifiers (Δ) are similar to the g-factors in physics. The value of Δ_{Ge} was adjusted slightly by 0.0000606 to match experimental data. Since Δ_T is derived from Δ_{Ge} it also required an adjustment, although slightly smaller at 0.0000255. This could be a result of the value of one or more input variables (such as the fine structure constant, electron radius or Planck constant) being incorrect at the fifth digit. The fine structure constant (α_e) is used in the derivation in Eq. A.2 as the correction factor is set against a well-known value.

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.[11] A velocity of 3.3 x 10^7 m/s (11% of the speed of light) would reduce three g-factors to one based on relativity principles.

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

$$\Delta_{Ge} = \delta_{Ge} = 2A_l^3 K_e^{28} \qquad \textbf{(A.3)}$$

$$\Delta_T = \Delta_e \Delta_{Ge} \qquad \textbf{(A.4)}$$

The electromagnetic coupling constant, better known as the fine structure constant (α), can also be derived. In this paper, it is also used with a sub-notation "e" for the electron (α_e).

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

The gravitational coupling constant for the electron can also be derived. α_{Ge} is baselined to the electromagnetic force at the value of one, whereas some uses of this constant baseline it to the strong force with a value of one (α_G = 1.7 x 10^{-45}). The derivation matches known calculations as $\alpha_{Ge} = \alpha_G / \alpha_e$ = 2.40 x 10^{-43}.

$$\alpha_{Ge} = \frac{K_e^8 \lambda_l^7 \delta_e}{\pi A_l^7 O_e \delta_{Ge}} \quad \textbf{(A.6)}$$

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