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 ($F=kq_1q_2/r^2$), the law of universal gravitation ($F=Gm_1m_2/r^2$) and Newton's second law of motion (F=ma). All of these equations are ultimately derived from one fundamental energy wave equation.

This paper is a supplement to four papers that describe the energy, forces and constants in physics titled: 1) *Particle Energy and Interaction*[1], 2) *Forces*[2], 3) *Atomic Orbitals*[3] and 4) *Fundamental Physical Constants*[4]. 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 led to the confusion about the nature of particles or their medium are revisited with potential explanations, including the Michelson-Morley experiment, neutrino oscillation and the photoelectric effect.

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 of different particles, in addition to differentiating longitudinal and transverse waves.

Notation	Meaning
K_e	Particle wave center count (e – electron)
λ_l λ_t	Wavelength (l – longitudinal wave, t – transverse wave)
g_λ g_A g_p	g-factor (λ – electron orbital g-factor, A – 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 - *dimensionless*
K	Particle wave center count	variable - *dimensionless*
Q	Particle count in a group	variable - *dimensionless*
	Particle Constants	
K_e	Electron particle count	10 - *dimensionless*

O_e	Electron outer shell multiplier	2.138743820 – *dimensionless*
g_λ	Electron orbital g-factor (*revised*)	0.9873318320 – *dimensionless*
g_A	Electron spin g-factor (*revised*)	0.9826905018 – *dimensionless*
g_p	Proton orbital g-factor (*revised*)	0.9898125300 – *dimensionless*

Table 1.1.2 – Energy Wave Equation Constants and Variables

Method for calculating the values of the constants

The method used for deriving and calculating each of the constants is found in the *Fundamental Physical Constants* paper. The values may continue to be refined, and if so, will be posted online at: http://energywavetheory.com/equations.

1.2. Principles

The following are the 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. Energy constantly flows as longitudinal waves throughout the universe, creating particles and responsible for the forces that act upon particles. Its energy (E) is proportional to **amplitude** (A), **wavelength** (λ), **wave speed** (c) and **density** (ρ) of a defined **volume** (V).

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

2. Frequency (f) 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 universal default values, based on a fundamental particle, but may change with constructive and destructive wave interference.

5. The fundamental particle, also called a wave center, reflects a wave such that it can be standing in form. The fundamental particle may be the neutrino, as calculated in *Particle Energy and Interaction*.

6. Standing waves may form when reflected by a wave center, and remain standing in form as long as wave amplitude is greater than the universal wave amplitude, which is half the longitudinal amplitude constant ($A_l/2$). In any given axis of spherical waves, the incoming universal waves have amplitude of $A_l/2$. At the core, where it is constructive, it combines at a wave center to be an amplitude with a value of A_l for the fundamental particle.

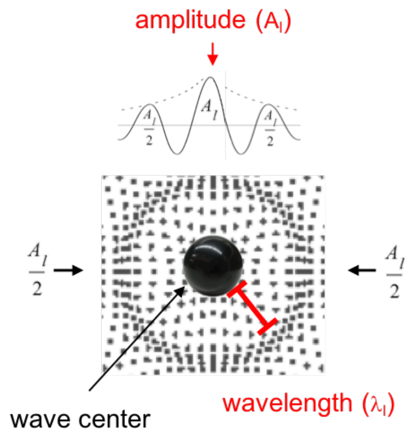

Fig 1.2.1 – Wave center reflecting incoming waves to create a standing wave of energy - the fundamental particle

7. Longitudinal wave amplitude decreases at each wavelength proportional to distance, due to spherical waves that spread out from the source.

8. Wave centers (K) may combine, forming new particles if they are placed in geometrically stable positions. Wave centers move to minimize wave amplitude, preferring the node of a standing wave where amplitude is zero. It is also referred to as particle wave center count (K). When wave centers combine, amplitude and wavelength increase proportional to the number of wave centers reflecting waves. Because amplitude has increased, the number of wavelengths for standing waves also increases.

9. The electron is calculated to be a particle wave center count of ten (K=10), which means ten waves centers at the core, as calculated in *Particle Energy and Interaction*. Given the frequency of its occurrence in wave equations, it is given a special constant (K_e), where K_e=10. When waves are standing in form, within a given volume, the longitudinal wave energy (E_l) is equal to the electron's rest energy (E_e).

$$E_l = E_e = m_e c^2 \quad \textbf{(1.3)}$$

10. The amplitude at the core of the electron particle is proportional to the number of wave centers, which is 10 times A_l (K_eA_l). Particle energy is calculated based on spherical incoming and outgoing waves in three dimensions, so it is $K_e^6A_l^6$, but for an outgoing wave in a single axis, it starts at K_eA_l, and then amplitude declines with each wavelength ($K_e\lambda_l$). The wave amplitude at the first wavelength is half of Planck charge (q_P).

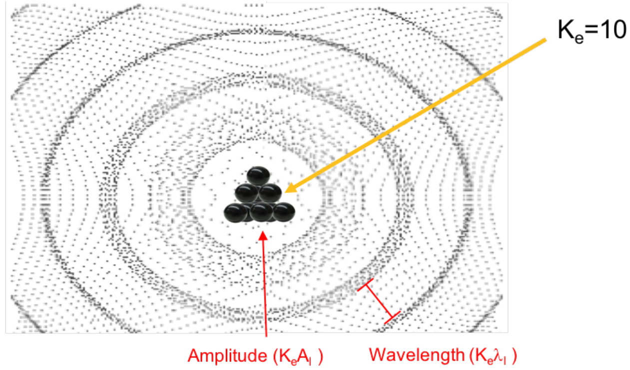

Fig 1.2.2 – Electron formed from standing waves; amplitude at first wavelength is the Planck charge

11. The amplitude of the electron's standing waves is greater than the universal wave amplitude from the core until it reaches ten (K_e) electron wavelengths ($K_e\lambda_l$). This forms the perimeter where standing wave volume (rest energy or mass) of the electron is measured. It is the classical electron radius (r_e), or $K_e^2\lambda_l$. Because measurements are taken on Earth, moving against the universal reference frame, g-factors are used (g_λ). See *Fundamental Physical Constants* for an explanation on the g-factors in the wave equations.

$$r_e = K_e^2 \lambda_l g_\lambda \tag{1.4}$$

12. Beyond the electron's radius, longitudinal waves continue to travel but in the form of traveling waves. The waves reflected by the wave centers in the electron now combine with wave interference with universal waves, or with waves from other particles. The universal waves will cancel in any given direction, thus are not calculated in wave interference equations (only wave interference from other particles). The wave amplitude after transitioning to traveling waves is the elementary charge (e_e).

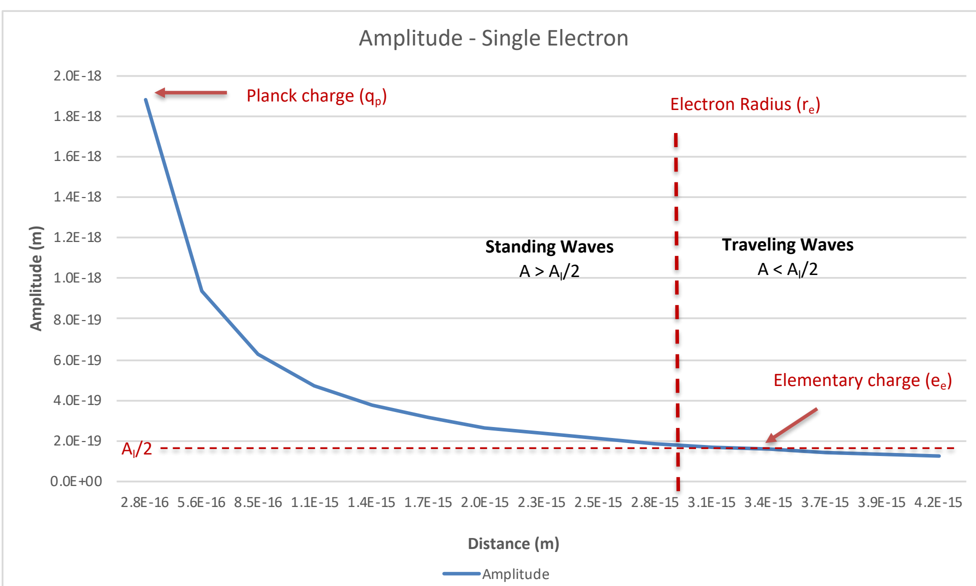

Fig 1.2.3 – Wave amplitude decline from a single electron at distance. Standing waves lose form when amplitude reaches the universal amplitude (A_l/2) and transition to traveling waves.

13. Beyond standing waves, the ratio of amplitude to wavelength is now less than 1, as described in Eq. 1.5. Longitudinal wave energy (E_l) can be calculated at any point in space from the electron's energy (E_e) with this ratio, as described in Eq. 1.6.

$$\Delta A < \Delta\lambda \tag{1.5}$$

$$E_l = E_e\left(\frac{\Delta A}{\Delta\lambda}\right) \tag{1.6}$$

14. Wave amplitude decline originates at the electron core, as described in Fig. 1.2.3, yet traveling waves begin at the electron radius (r_e). The ratio of the electron radius to distance (r) is used to determine the longitudinal wave energy at any distance. The variables for this ratio will be separated in parentheses on the right side of equations in this paper.

$$E_l = E_e\left(\frac{r_e}{r}\right) \tag{1.7}$$

15. Multiple particles in the same wave phase in a vicinity, such as a group of protons in an atomic nucleus, are given the letter Q as a dimensionless count of the number of particles in a group. For example, five protons in group 1 is $Q_1=5$. Waves are constructive, so if they are within close proximity, it can be approximated as fully constructive, additive waves. If the group interacts with a single particle (1) at distance (r), it is represented as the following Eq. 1.8 (energy is proportional to the square of amplitude). The ratio from Eq. 1.6 is now complete as a ratio of amplitude to wavelength (distance). It is the equation for binding energy between a nucleus and a single electron.

$$E_l = E_e r_e\left(\frac{Q_1(1)}{r}\right) \tag{1.8}$$

16. When a second group of particles (Q_2) is measured at a distance (r) from the group of particles (Q_1), it is also constructive and added together as Q_2. Waves in the same phase such as electrons and anti-protons, or positrons and protons, will be constructive and add together. Waves in opposite phase such as electrons and protons will be destructive wave interference. It is measured at the distance (r) and does not require the proportion of electron radius like Q_1.

$$E_l = E_e r_e\left(\frac{Q_1 Q_2}{r}\right) \tag{1.9}$$

17. **Electric Force.** While particle standing waves are often measured as rest energy or mass (energy without c^2), traveling waves are often measured or calculated as a force. Force is energy exerted over distance, represented in Eq. 1.10 for the electric force. Substituting for E_l in Eq. 1.9, yields the electric force expressed in classical terms for the electron energy (E_e) and radius (r_e). **See Section 2.4 for proof**.

$$F_e = \frac{E_l}{r} \tag{1.10}$$

$$F_e = E_e r_e \left(\frac{Q_1 Q_2}{r^2} \right) \quad \textbf{(1.11)}$$

18. Gravitational Force. Gravity is the electric force, but a very slight reduction of outgoing wave amplitude (α_{ge}) as a result of wave centers that are off node, resulting in particle spin. It results in a shading effect between particles, causing the gravitational force. **See Section 2.5 for proof**.

$$F_g = E_e r_e \left(\frac{\alpha_{Ge} Q_1 Q_2}{r^2} \right) \quad \textbf{(1.12)}$$

19. Strong Force. The strong force is an increase in one-dimensional wave amplitude of the electric force, as two charged particles at very close range convert incoming spherical waves to a one-dimensional (axial) wave. The increase is the inverse of the fine structure constant (α_e). See the *Forces* paper for proof.

$$F_s = E_e r_e \left(\frac{1}{\alpha_e} \frac{Q_1 Q_2}{r^2} \right) \quad \textbf{(1.13)}$$

20. Orbital Force. A wave passing through two particles (i.e. quarks) at close range converting spherical waves to one-dimensional waves goes through a second transition of wave amplitude increase, which is the inverse of the fine structure constant now squared (α_e^2). This force is responsible for keeping an electron in orbit around a proton. See the *Atomic Orbitals* paper for proof.

$$F_o = E_e r_e \left(\frac{1}{\alpha_e} \frac{Q_1 Q_2}{r^2} \right) \left(r_e \frac{1}{\alpha_e} \frac{Q_3}{r} \right) \quad \textbf{(1.14)}$$

21. Photons. Photons are transverse waves of energy (E_t) as a result of particle vibration. Longitudinal wave energy (E_l), i.e. the electric force, is always conserved. Two photons are generated, although one may recoil to the atom's nucleus. Thus, a photon's energy is half the longitudinal energy, expressed in Eq. 1.14. Therefore, this energy is also expressed as a ratio of amplitude to wavelength. **See Section 2.3 for proof**.

$$E_t = \frac{1}{2} E_l \quad \textbf{(1.15)}$$

$$E_t = \frac{1}{2} E_e \left(\frac{\Delta A}{\Delta \lambda} \right) \quad \textbf{(1.16)}$$

2. Deriving Key Equations

2.1. Energy and Force Relationships

The following sections describe the fundamental energy and force equations. 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.

Figs. 2.1.1 and 2.1.2 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 the Planck relation.
- Two or more particles with zero amplitude. This is the seen in annihilation, when two particle longitudinal energies are completely transferred to transverse (photon) energy.

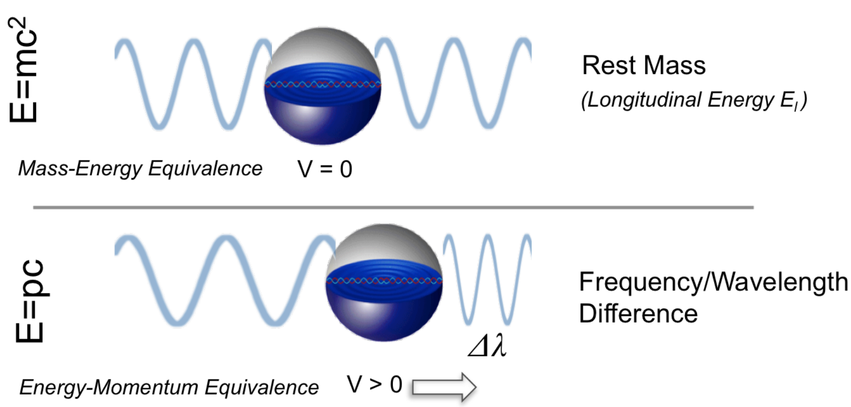

Fig 2.1.1 –Energy Relationship – Single Particle

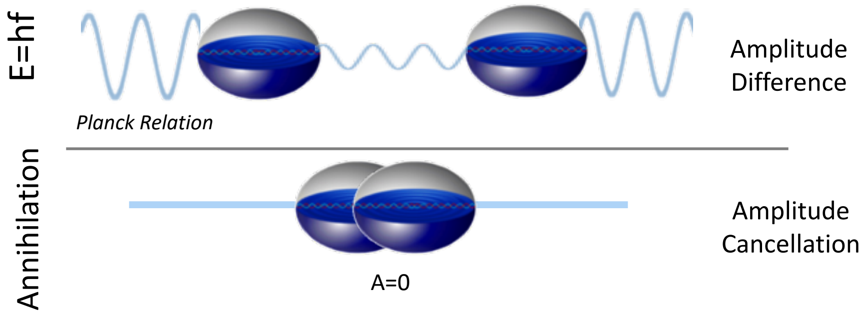

Fig 2.1.2 –Energy Relationship – Particle Interaction

2.2. Mass-Energy Equivalence (E=mc²)

From Key Principle #8 (Section 1.2), 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 is when waves become traveling waves again. Standing wave energy is stored energy.

Wave energy equation from (Eq. 1.1)

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

Eq. 2.2.1 is rewritten for three-dimensional in-waves and out-waves that create standing waves.

$$E_l = \rho V_l \left(\frac{c}{\lambda_l}\right)_{in} \left(\frac{A_l^3}{r^2}\right)_{in} \left(\frac{c}{\lambda_l}\right)_{out} \left(\frac{A_l^3}{r^2}\right)_{out} \quad \textbf{(2.2.2)}$$

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

$$E_l = \rho \left(\frac{4}{3}\pi r^3\right) \frac{c^2}{\lambda_l^2} \left(\frac{A_l^3}{r^2}\right)^2 \quad \textbf{(2.2.3)}$$

Wavelength and amplitude are affected by the number of wave centers (K). Energy at first wavelength, E_{core}.

$$E_{core} = \rho \left(\frac{4}{3}\pi (K\lambda_l)^3\right) \frac{c^2}{\lambda_l^2} \left(\frac{(KA_l)^3}{(K\lambda_l)^2}\right)^2 \quad \textbf{(2.2.4)}$$

Energy is a summation of each standing wavelength, from n=1 to K wave centers, declining in amplitude with each wavelength.

$$E_{l(K)} = \sum_{n=1}^{K} \rho \left(\frac{4}{3}\pi (n(K\lambda_l))^3 - \left(\frac{4}{3}\pi ((n-1)K\lambda_l)^3 \right) \right) \frac{c^2}{\lambda_l^2} \left(\frac{(KA_l)^3}{(n(K\lambda_l))^2} \right)^2 \qquad \textbf{(2.2.5)}$$

Simplify Eq. 2.2.5.

$$E_{l(K)} = \frac{4\pi\rho K^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.2.6)}$$

Mass is stored (standing wave) energy. It is the wave constants in Eq. 2.2.6, where wave centers (K) is variable.

$$m_{(K)} = \frac{4\pi\rho K^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.2.7)}$$

Substitute mass (m) into 2.2.6 to replace constants. Only c^2 remains. $E=mc^2$.

$$E_l = mc^2 \qquad \textbf{(2.2.8)}$$

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.

$$m_{(10)} = \frac{4\pi\rho K^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} = 9.109 \cdot 10^{-31}\,(kg) \qquad \textbf{(2.2.9)}$$

Outer Shell Multiplier (O): In Eq. 2.2.6, the particle energy is represented by the summation of energy at each spherical shell. The electron is the most common particle and a constant was given to make this equation more readable.

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \qquad \textbf{(2.2.10)}$$

Electron Rest Energy (E_e): Eq. 2.2.6 is rewritten specific to the electron with the K_e and O_e constants for readability. This is the format used in most of the wave equations.

$$E_e = E_{l(10)} = \frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} = 8.1871 \cdot 10^{-14}\left(\frac{kg\,(m^2)}{s^2}\right) \quad \textbf{(2.2.11)}$$

2.3. Planck Relation (E=hf)

From Key Principle #21 (Section 1.2), photon energy, otherwise known as Planck's relation, is a result of a transverse waves from the vibration of a particle due to a difference in longitudinal wave amplitude between two particles. The photon's energy is half of the longitudinal wave energy (Eq. 1.15).

Note: Energy and frequency will first be described in classical terms for an understanding of the process, then converted to wave equation format.

Photon energy is transverse wave energy released from longitudinal waves (from Eq. 1.16).

$$E_t = \frac{1}{2}E_e\left(\frac{\Delta A}{\Delta\lambda}\right) \quad \textbf{(2.3.1)}$$

The change in amplitude is given a variable (amplitude factor - δ) as a measurement of wave interference, set to one (1) for hydrogen.

$$\Delta A = \delta \quad \textbf{(2.3.2)}$$

From Eq. 1.9, when using distance in meters, electron radius is used in equation. Transverse energy is the delta in longitudinal energy at two points (initial r_0 and final r)

$$E_t = \frac{1}{2}E_e r_e\left(\frac{\delta}{r} - \frac{\delta}{r_0}\right) \quad \textbf{(2.3.3)}$$

From *Particle Energy and Interaction,* frequency is calculated using wave constants as the following (proven below).

$$f = \frac{3\lambda_l c}{16K_e^4 A_l}\left(\frac{\delta}{r} - \frac{\delta}{r_0}\right) \quad \textbf{(2.3.4)}$$

Substituting for electron energy (from Eq. 2.2.11) and radius (from Eq. 1.4) into Eq. 2.3.3.

$$E_t = \frac{1}{2}\frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3}(K_e^2\lambda_l g_\lambda)\left(\frac{\delta}{r}-\frac{\delta}{r_0}\right) \quad \textbf{(2.3.5)}$$

Simplify Eq. 2.3.5. When r is the Bohr radius (a_0), the equation resolves to the Rydberg unit of energy (proven below).

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta}{r}-\frac{\delta}{r_0}\right) \quad \textbf{(2.3.6)}$$

The correct variables are wave interference (amplitude factor) and distance. But Planck relation uses a variable for frequency (masking two variables). Divide Eq. 2.3.6 by 2.3.4.

$$\frac{E_t}{f} = \frac{\dfrac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda}{\dfrac{3\lambda_l c}{16 K_e^4 A_l}}\left(\frac{\delta}{r}-\frac{\delta}{r_0}\right) \quad \textbf{(2.3.7)}$$

Simplify Eq. 2.3.7 where the variables are in parentheses on right and constants on the left.

$$\frac{E_t}{f} = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda \left(\frac{\delta}{r}-\frac{\delta}{r_0}\right) \quad \textbf{(2.3.8)}$$

The constants in Eq. 2.3.8 are the Planck constant (h).

$$h = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda \quad \textbf{(2.3.9)}$$

The Planck relation is the constants in Eq. 2.3.9, and the frequency in Eq. 2.3.4.

$$E_t = hf \quad \textbf{(2.3.10)}$$

Proof: Solving for the wave constants in Eq. 2.3.9 for Planck constant yields the accurate numerical value and units.

$$h = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda = 6.626\cdot 10^{-34}\left(\frac{kg\,(m^2)}{s}\right) \quad \textbf{(2.3.11)}$$

Proof: Solving for Eq. 2.3.4 at the Bohr radius (a_0) for a hydrogen atom (amplitude factor is one - δ=1) yields the correct frequency.

$$f_0 = \frac{3\lambda_l c}{16K_e^4 A_l}\left(\frac{1}{a_0}\right) = 3.29\cdot10^{15}\left(\frac{1}{s}\right) \tag{2.3.12}$$

Proof: Solving for the energy of a hydrogen atom at the Bohr radius (a_0) in Eq. 2.3.6 yields the Rydberg unit of energy.

$$E_{Ry} = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{1}{a_0}\right) = 2.18\cdot10^{-18}\left(\frac{kg\,(m^2)}{s^2}\right) \tag{2.3.13}$$

2.4. Coulomb's Law (F=kqq/r²)

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.

Note: Force and energy will first be described in classical terms for an understanding of the process, then converted to wave equation format.

From Eq. 1.11, where force is energy over distance (r), for two groups of particles (Q).

$$F_e = E_e r_e \left(\frac{Q_1 Q_2}{r^2}\right) \tag{2.4.1}$$

Because Coulomb's law is expressed in terms of charge (q or e_e), not numerical particle count (Q), it needs to be converted.

$$q_1 = Q_1 e_e \qquad q_2 = Q_2 e_e \tag{2.4.2}$$

Substitute for Q_1 and Q_2 (from Eq. 2.4.2) into Eq. 2.4.1. This is the classical form of Coulomb's law.

$$F_e = E_e r_e \left(\frac{q_1 q_2}{e_e^2 r^2}\right) \tag{2.4.3}$$

Converting to wave constants. Elementary charge (e_e) was derived in *Fundamental Physical Constants*. Value and units match (proven below).

$$e_e = \sqrt{\frac{3\pi\lambda_l A_l}{K_e^4}}\cdot g_A^{-1} \tag{2.4.4}$$

Substituting for electron energy (from Eq. 2.2.11), radius (from Eq. 1.4), and elementary charge (from Eq. 2.4.4) into Eq. 2.4.3.

$$F_e = \frac{4\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{1}{\sqrt{\frac{3\pi\lambda_l A_l}{K_e^4} \cdot g_A^{-1}}} \right)^2 \left(\frac{q_1 q_2}{r^2} \right) \quad \textbf{(2.4.5)}$$

Simplify Eq. 2.4.5.

$$F_e = \frac{4\rho K_e^{11} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2 \left(\frac{q_1 q_2}{r^2} \right) \quad \textbf{(2.4.6)}$$

The constants in Eq. 2.4.6 are Coulomb's constant (k).

$$k_e = \frac{4\rho K_e^{11} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2 \quad \textbf{(2.4.7)}$$

Substitute Eq. 2.4.7 into 2.4.6 and it's Coulomb's law.

$$F_e = k_e \left(\frac{q_1 q_2}{r^2} \right) \quad \textbf{(2.4.8)}$$

Proof: Coulomb's constant was calculated in *Forces*. It matches in numerical value. In wave theory, Coulombs (C) is measured in amplitude (meters). Coulomb's constant is therefore a force, in terms of units.

$$k_e = \frac{4\rho K_e^{11} A_l^5 c^2 O_e}{9\lambda_l^3} g_\lambda g_A^2 = 8.988 \cdot 10^9 \left(\frac{kg\,(m)}{s^2} \right) \quad \textbf{(2.4.11)}$$

Proof: Elementary charge was derived in *Fundamental Physical 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.

$$e_e = \sqrt{\frac{3\pi\lambda_l A_l}{K_e^4} \cdot g_A^{-1}} = 1.602 \cdot 10^{-19}\,(m) \quad \textbf{(2.4.12)}$$

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

Similar to Coulomb's Law (Section 2.4), the equation for the Law of 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.

Note: Force and energy will first be described in classical terms for an understanding of the process, then converted to wave equation format.

From Eq. 1.12, the force of gravity is a slight loss of wave amplitude in the electric force.

$$F_g = E_e r_e \left(\frac{\alpha_{Ge} Q_1 Q_2}{r^2} \right) \quad \textbf{(2.5.1)}$$

Since electron energy (E_e) is $m_e c_2$, it can be substituted from Eq. 2.5.1.

$$F_g = m_e c^2 r_e \alpha_{Ge} \left(\frac{Q_1 Q_2}{r^2} \right) \quad \textbf{(2.5.2)}$$

Because the law of gravitation expresses particles in terms of mass (m), not numerical particle count (Q), it needs to be converted (based on electron mass (m_e).

$$m_1 = Q_1 m_e$$

$$m_2 = Q_2 m_e \quad \textbf{(2.5.3)}$$

Substitute Eq. 2.5.3 into 2.5.2.

$$F_g = m_e c^2 r_e \alpha_{Ge} \left(\frac{m_1}{m_e} \frac{m_2}{m_e} \frac{1}{r^2} \right) \quad \textbf{(2.5.4)}$$

Simplify Eq. 2.5.4.

$$F_g = \frac{1}{m_e} c^2 r_e \alpha_{Ge} \left(\frac{m_1 m_2}{r^2} \right) \quad \textbf{(2.5.5)}$$

Converting to wave constants. The gravitational coupling constant for the electron (α_{ge}) was derived in *Forces* (proven below).

$$\alpha_{Ge} = \frac{K_e}{6\pi}\left(\frac{\lambda_l}{4K_e^{15}A_l}\right)^3 g_\lambda^2 \qquad \textbf{(2.5.6)}$$

Substituting for electron energy (from Eq. 2.2.11), radius (from Eq. 1.4), and gravitational coupling constant (from Eq. 2.5.6) into Eq. 2.5.5.

$$F_g = \frac{1}{\dfrac{4\pi\rho K_e^5 A_l^6 O_e}{3\lambda_l^3}} c^2 \left(K_e^2 \lambda_l g_\lambda\right) \left(\frac{K_e}{6\pi}\left(\frac{\lambda_l}{4K_e^{15}A_l}\right)^3 g_\lambda^2\right)\left(\frac{m_1 m_2}{r^2}\right) \qquad \textbf{(2.5.7)}$$

Simplify Eq. 2.5.7.

$$F_g = \frac{\lambda_l^7 c^2}{\pi^2 \rho K_e^{47} O_e} \frac{1}{(2A_l)^9} g_\lambda^3 \left(\frac{m_1 m_2}{r^2}\right) \qquad \textbf{(2.5.8)}$$

The constants in Eq. 2.5.8 are the gravitational constant (G).

$$G = \frac{\lambda_l^7 c^2}{\pi^2 \rho K_e^{47} O_e} \frac{1}{(2A_l)^9} g_\lambda^3 \qquad \textbf{(2.5.9)}$$

Substitute Eq. 2.5.9 into 2.5.8 yields the law of universal gravitation.

$$F = G\frac{m_1 m_2}{r^2} \qquad \textbf{(2.5.10)}$$

Proof: The Gravitational constant was calculated in *Forces*. It matches in numerical value and in units.

$$G = \frac{\lambda_l^7 c^2}{\pi^2 \rho K_e^{47} O_e} \frac{1}{(2A_l)^9} g_\lambda^3 = 6.674 \cdot 10^{-11} \frac{m^3}{(kg)\, s^2} \qquad \textbf{(2.5.11)}$$

Proof: The gravitational coupling constant for the electron is a very slight 2.4 x 10^{-43} when compared to the electric force. It is dimensionless.

$$\alpha_{Ge} = \frac{K_e}{6\pi}\left(\frac{\lambda_l}{4K_e^{15}A_l}\right)^3 g_\lambda^2 = 2.40 \cdot 10^{-43} \qquad \textbf{(2.5.12)}$$

2.6. 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 2.6.1 and 2.6.2.

$$E_{l(in)} = \frac{1}{2}\rho\left(\frac{4}{3}\pi(K_e\lambda_l)^3\right)\left(\frac{c}{\lambda_l\sqrt{\left(1+\frac{v}{c}\right)}}\frac{(K_eA_l)^3}{(K_e\lambda_l)^2}\right)\left(\frac{c}{\lambda_l\sqrt{\left(1-\frac{v}{c}\right)}}\frac{(K_eA_l)^3}{(K_e\lambda_l)^2}\right) \quad \textbf{(2.6.1)}$$

$$E_{l(out)} = \frac{1}{2}\rho\left(\frac{4}{3}\pi(K_e\lambda_l)^3\right)\left(\frac{c}{\lambda_l\sqrt{\left(1+\frac{v}{c}\right)}}\frac{(K_eA_l)^2K_e(A_l-A_l\sqrt{\alpha_{Ge}})}{(K_e\lambda_l)^2}\right)\left(\frac{c}{\lambda_l\sqrt{\left(1-\frac{v}{c}\right)}}\frac{(K_eA_l)^2K_e(A_l+A_l\sqrt{\alpha_{Ge}})}{(K_e\lambda_l)^2}\right) \quad \textbf{(2.6.2)}$$

The gravitational coupling constant (α_{Ge}) is negligible (2.4×10^{-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. 2.6.1 and 2.6.2

$$E = E_{l(in)} + E_{l(out)} \quad \textbf{(2.6.3)}$$

Subtituting Eqs. 2.6.1 and 2.6.2 into 2.6.3 and solving (assuming negligble α_{Ge})

$$E = \frac{4\pi\rho K_e^5 A_l^6 c^2}{3\lambda_l^3\sqrt{1+\frac{v}{c}}\cdot\sqrt{1-\frac{v}{c}}} \quad \textbf{(2.6.4)}$$

Simpifying the square roots in the demonimator.

$$E = \frac{4\pi\rho K_e^5 A_l^6 c^2}{3\lambda_l^3}\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \quad \textbf{(2.6.5)}$$

Lorentz factor is seen in Eq. 2.6.5.

$$\gamma = \frac{1}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(2.6.6)}$$

From Eq. 2.2.9, rest mass of electron when K=10 (K_e)

$$m_0 = \frac{4\pi \rho K_e^5 A_l^6}{3\lambda_l^3} \quad \textbf{(2.6.7)}$$

Subtitute Eq. 2.6.7 into 2.6.5

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \textbf{(2.6.8)}$$

Square both sides to remove the square root

$$E^2 = \frac{m_0^2 c^4}{1 - \frac{v^2}{c^2}} \quad \textbf{(2.6.9)}$$

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

$$m^2 c^4 = \frac{m_0^2 c^4}{1 - \frac{v^2}{c^2}} \quad \textbf{(2.6.10)}$$

$$m^2 c^4 \left(1 - \frac{v^2}{c^2}\right) = m_0^2 c^4 \quad \textbf{(2.6.11)}$$

$$m^2 c^4 - \frac{m^2 v^2 c^4}{c^2} = m_0^2 c^4 \quad \textbf{(2.6.12)}$$

Rearrange to isolate "mv"

$$m^2 c^4 - (mv)^2 c^2 = m_0^2 c^4 \quad \textbf{(2.6.13)}$$

Momentum (p) is mass times velocity (v)

$$p = mv \tag{2.6.14}$$

Subtitute Eq. 2.7.14 into 2.7.13

$$m^2c^4 - p^2c^2 = m_0^2c^4 \tag{2.6.15}$$

$$E^2 - p^2c^2 = m_0^2c^4 \tag{2.6.16}$$

Complete energy-momentum equation.

$$E^2 = (m_0c^2)^2 + (pc)^2 \tag{2.6.17}$$

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

$$E = pc \tag{2.6.18}$$

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

Newton's Second Law of motion is particle velocity, so it requires the complete form of the energy wave equation (Eqs. 2.6.1 and 2.6.2). It is a continuation of the energy-momentum equation, expressed as a force instead of energy, so the starting point for this derivation is Eq. 2.6.18.

From Eq. 2.6.18, a particle in motion has energy, E=pc. Note this starts from a wave equation, but does not duplicate the steps from Section 2.6.

$$E = pc \tag{2.7.1}$$

Force is energy exerted over distance (r).

$$F = \frac{E}{r} \tag{2.7.2}$$

Momentum (p), is mass times velocity.

$$p = mv \tag{2.7.3}$$

Substitute Eq. 2.7.3 into 2.7.1, and then into Eq. 2.7.2.

$$F = \frac{mvc}{r} \quad (2.7.5)$$

Time is how long it takes a wave traveling at speed (c) to travel a distance (r).

$$t = \frac{r}{c} \quad (2.7.6)$$

Acceleration is a change in velocity over time.

$$a = \frac{v}{t} \quad (2.7.7)$$

Substitute time from Eq. 2.7.6 into 2.7.7.

$$a = \frac{vc}{r} \quad (2.7.8)$$

Acceleration is the velocity, speed of light and distance components in Eq. 2.7.5, which is energy-momentum over distance. Substitute Eq. 2.7.8 into 2.7.5 for Newton's second law.

$$F = ma \quad (2.7.9)$$

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 2.6, 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. 2.6.6 as relative to the initial wavelength.

From Eq. 2.6.8	$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}}$$	**(2.8.1)**
Lorentz factor from Eq. 2.6.6.	$$\gamma = \frac{1}{\sqrt{1 - \frac{\Delta v^2}{c^2}}}$$	**(2.8.2)**
Substitute Eq. 2.8.2 into Eq. 2.8.1. **Relativistic energy.**	$$E = \gamma m_0 c^2$$	**(2.8.3)**
Rearrange Eq. 2.8.3	$$\frac{E}{c^2} = \gamma m_0$$	**(2.8.4)**
Mass is energy without consideration of wave speed.	$$m = \frac{E}{c^2}$$	**(2.8.5)**
Subtitute Eq. 2.8.5 into 2.8.4. **Relativistic mass.**	$$m = \gamma m_0$$	**(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.[5]

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.

$$f_0 = \frac{c}{\lambda_l} \quad \textbf{(2.8.9)}$$

A change in frequency based on a change in wavelength

$$\Delta f_x = \frac{c}{\Delta\lambda_x} \quad \textbf{(2.8.10)}$$

Subtitute Eq. 2.8.8 into 2.8.10

$$\Delta f_x = \frac{\gamma c}{\lambda_l} \quad \textbf{(2.8.11)}$$

Substitute Eq. 2.8.9 into 2.8.11.

$$\Delta f_x = \gamma f_0 \quad \textbf{(2.8.12)}$$

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

$$\Delta t_x = \gamma t_0 \quad \textbf{(2.8.13)}$$

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. When in motion, its electron will still be at the same number of 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.[6]

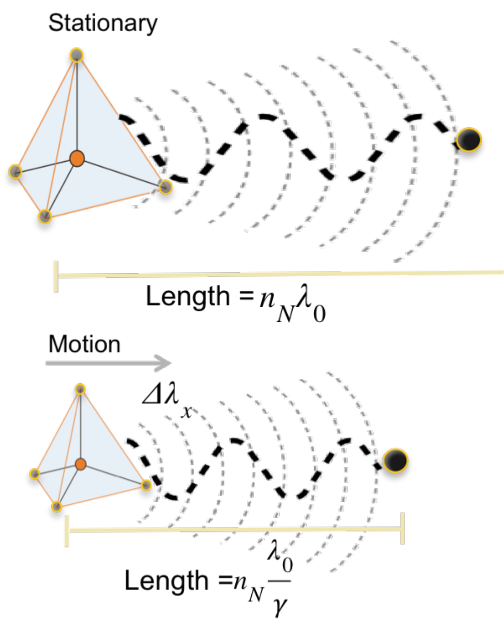

Fig 2.8.1 –Length Contraction

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 where n is the number of wavelength.

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

Length changes because wavelength

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

contracts in X direction

Subtitute Eq 2.8.14 into 2.8.16

$$\Delta L_x = \sum n_N \frac{\lambda_0}{\gamma} \quad \textbf{(2.8.17)}$$

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

$$\Delta L_x = \frac{L_o}{\gamma} \quad \textbf{(2.8.18)}$$

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**.[7] 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.[8] 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.

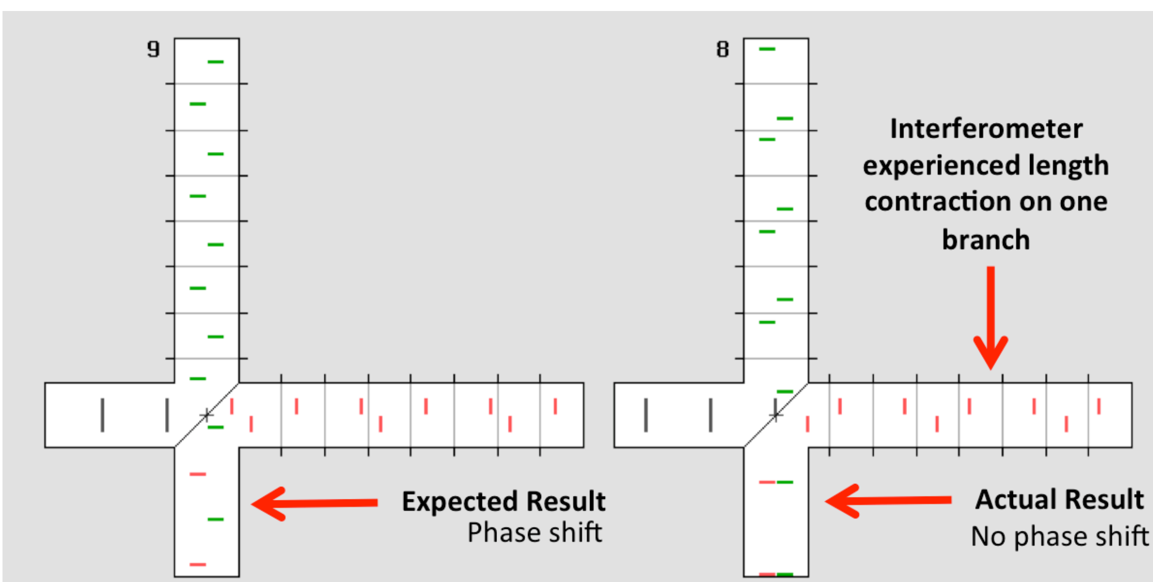

Fig 3.1 – Michelson Interferometer

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.[9] 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.

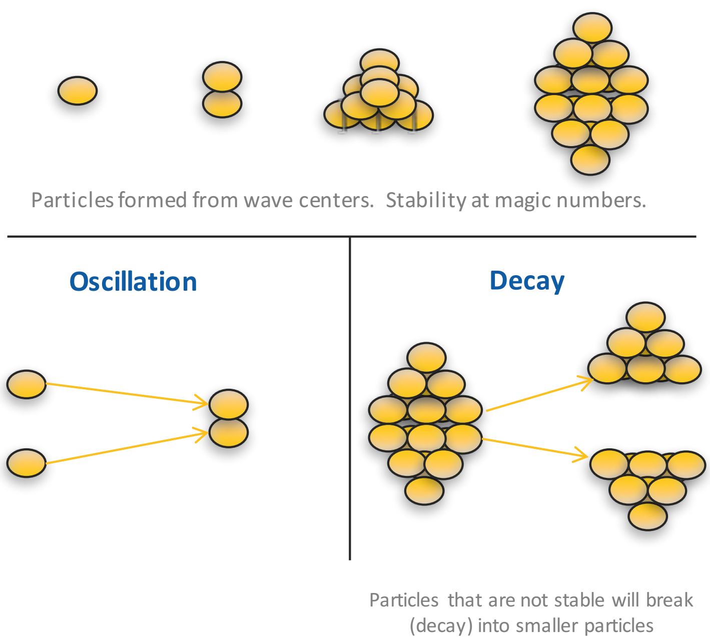

Fig 3.2 – Particle Creation – Oscillation and Decay

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.[10] 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.

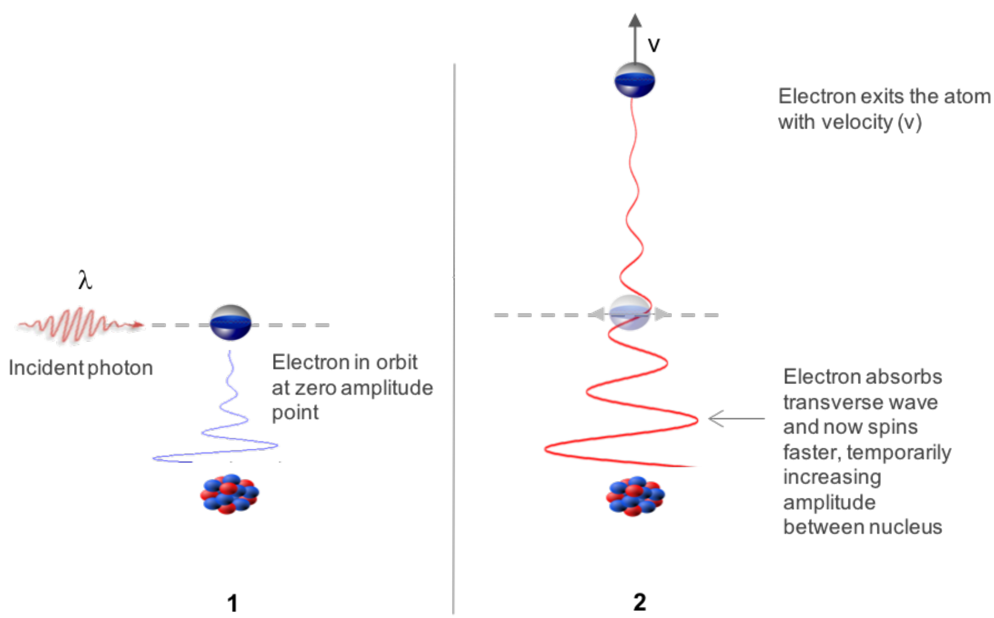

Fig 3.3 – Electron path – creating a transverse wave

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.[11] 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.

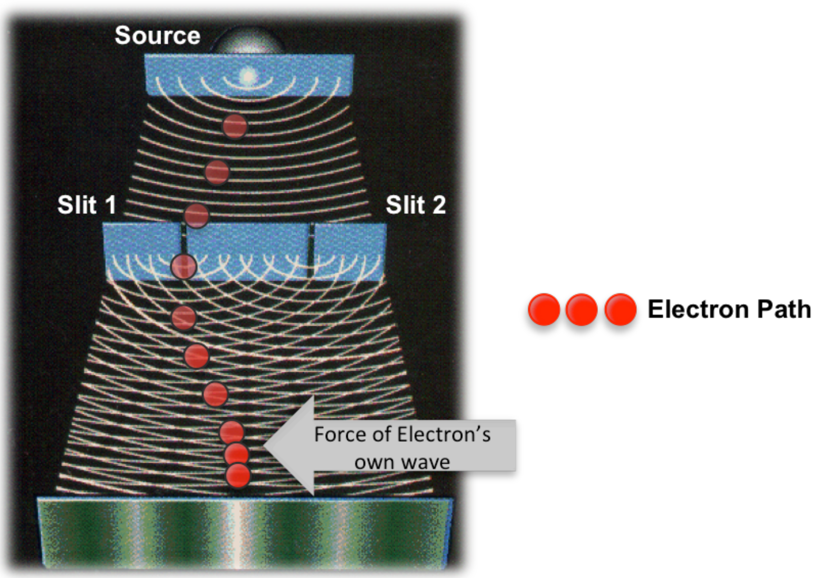

Fig 3.4 – Double Slit Experiment

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.

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