# Particle Energy and Interaction: Explained and Derived by Energy Wave Equations

Jeff Yee

jeffsyee@gmail.com

February 12, 2017

## Summary

Subatomic particles, their interactions and the energy wave equation that governs their mass and motion are presented in this paper. There is one base energy wave equation, in two distinct forms, with four fundamental constants. The forms are longitudinal and transverse, and the four constants are wave speed, wavelength, amplitude and density. The equations are further derived based on wave differences – amplitude and wavelength – that are the cause of particle formation and interactions with other particles.

This challenges a century-old equation in physics, therefore the burden of proof of a newly proposed equation is to not only calculate and match data from existing experiments, but to also explain and derive other known equations as it is suggested that the new energy wave equations form the basis of energy equations from classical and quantum mechanics.

First, the new energy wave equations are proposed and used to match known data as proof that these equations work. In Section 1, amongst other calculations, these equations are used to:

- Calculate the rest energy and mass of subatomic particles that appear in nature
- Calculate the orbital distances, energies and wavelengths during hydrogen electron transitions
- Calculate the ionization energies of the first twenty elements
- Calculate the electron Compton wavelength and Bohr radius constants

Second, the equations are derived with an explanation of why they work, describing the reason for mass, the quantum jumps of the electron in an atomic orbit and what happens to particles in an antimatter collision. The equations give meaning to the way the universe works.

Third, and most importantly, the newly proposed energy wave equations are used to derive the current equations used for mass-energy, energy-momentum and Planck's relation. In addition, a derivation and explanation is given for relativity equations.

The findings in this paper conclude that particles and their interactions are not only governed by a simple equation that ties quantum and classical equations together, but that particles themselves are simply made from the building blocks of a wave center that is a reflecting source of energy waves that travel throughout the universe. This building block, possibly the neutrino, forms the basis of particle creation similar to how protons assembled in a nucleus give rise to different atomic elements.

Further experiments and calculations to confirm this hypothesis are suggested in the concluding remarks.

# 1. Energy Wave

This paper introduces longitudinal and transverse energy wave equations that can be used to calculate particle energy, mass and properties of the electromagnetic wave. These equations derive from a simple energy wave equation that consists of density, wave speed, wavelength and amplitude, which form matter and govern how particles interact and exchange energy.

The equations explained hereafter match experimental data of subatomic particles, including 1) particle mass and energy, 2) atomic orbitals, 3) photon energy and wavelengths of hydrogen orbital transitions and 4) ionization energies of the first twenty elements. This was accomplished with new energy wave equations without requiring the use of Planck's constant or the Rydberg constant. The results of the data are provided below and the constants and equations that they refer to are provided in Sections 1.1 and 1.2 respectively.

### Rest Energy of Leptons

The rest energy of elementary particles, including the lepton family of particles, were calculated using an equation that models standing wave energy, otherwise known as the Longitudinal Energy Equation, and shown in Table 1.1. It was assumed that particles consist of a fundamental particle as the building block; similar to the way atomic elements are constructed from an arrangement of nucleons. Although the calculated values in Table 1.1 differ up to 11.9% from the measured values of these particles, it should be noted that atomic weights of elements are not exact at integers and also differ from the nearest integer.

Further, the same Longitudinal Energy Equation that was used to calculate particle energy is also used to derive the Force Equation in the *Forces* paper, in which the particle force calculations for both electromagnetism and gravity have no difference from the measured values (0.000%).[1] Also, noteworthy is that the calculated values of wave center counts (K) of leptons happen at magic numbers that are consistent with atomic elements: 2, 8, 20, 28 and 50. Only a particle with a wave center count of 2 is not a known or discovered particle.

| **Core - Wave Centers *(K)*** | **1** | **2** | **8** | **10** | **20** | **28** | **50** |
|---|---|---|---|---|---|---|---|
| Particle Name | Neutrino | ? | Muon Neutrino | Electron | Tau Neutrino | Muon Electron | Tau Electron |
| Rest Energy (Calculated) - GeV | 2.39E-09 | 1.10E-07 | 1.63E-04 | 5.11E-04 | 1.73E-02 | 9.49E-02 | 1.76E+00 |
| **Rest Energy (Calculated) - Joules** | **3.83E-19** | **1.76E-17** | **2.61E-14** | **8.19E-14** | **2.78E-12** | **1.52E-11** | **2.81E-10** |
| Rest Energy (CODATA) - Joules | 3.52E-19 | | 2.72E-14 | 8.19E-14 | 2.48E-12 | 1.70E-11 | 2.85E-10 |
| *% Difference* | *8.60%* | | *-4.27%* | *0.00%* | *11.88%* | *-10.49%* | *-1.17%* |

**Table 1.1 – Rest Energy of Leptons**[2]

### Hydrogen Orbital Distances

Beyond its standing wave structure, a particle still has energy but transitions from standing waves to longitudinal traveling waves. However, when particles interact, they may create transverse waves. The transfer of longitudinal traveling waves to transverse waves is captured in the next set of data for photon wavelengths and energies. First, the potential positions of an electron in atomic orbitals must be established to use the equations.

Using the Orbital Equation, the distances were calculated for each traditional orbital (N). The distance is measured in both wavelengths (renamed n for the shell number) and in meters. The calculation for the first orbital matches the Bohr radius with 0.000% difference at 5.292E-11 meters. Although the remaining orbitals are not compared against measured results, they are assumed to be correct distance calculations. Otherwise, Tables 1.3 – 1.5 would not have correct calculations for the photon wavelengths and energies at these orbitals.

| **Orbital *(N)*** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|---|
| Shell n (Calculated) - wavelengths | 18,779 | 75,115 | 169,010 | 300,462 | 469,472 | 676,039 | 920,164 |
| **Radius (Calculated) - meters** | **5.292E-11** | **2.117E-10** | **4.763E-10** | **8.467E-10** | **1.323E-09** | **1.905E-09** | **2.593E-09** |
| Radius (Measured) - meters | 5.292E-11 | | | | | | |
| *% Difference* | *0.000%* | | | | | | |

**Table 1.2 – Hydrogen Orbital Distances**[3]

**Hydrogen Photon Wavelengths (Ionization)**

Using the Transverse Wavelength Equation and the wavelength shells (n) from Table 1.2, the wavelengths of photons absorbed during hydrogen ionization were calculated for each of the traditional orbitals (N). The difference from the calculated values to measured values range from 0.001% to 0.135% for various orbitals calculated.

| **Shell *(n)*** | **18,779** | **75,115** | **169,010** | **300,462** | **469,472** | **676,039** | **920,164** |
|---|---|---|---|---|---|---|---|
| Orbital (N) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Wavelength (Calculated) - meters** | **-9.113E-08** | **-3.645E-07** | **-8.201E-07** | **-1.458E-06** | **-2.278E-06** | **-3.281E-06** | **-4.465E-06** |
| Wavelength (Measured) - meters | -9.113E-08 | -3.645E-07 | -8.200E-07 | -1.460E-06 | -2.280E-06 | -3.280E-06 | |
| *% Difference* | *0.004%* | *0.001%* | *-0.017%* | *0.135%* | *0.080%* | *-0.017%* | |

**Table 1.3 – Hydrogen Photon Wavelengths (Ionization)** [4]

**Hydrogen Photon Wavelengths (Orbital Transition)**

Using the Transverse Wavelength Equation again, the wavelengths of photons emitted for hydrogen were calculated in orbital transition. For example, as the electron transitions from Orbital 3 to Orbital 2 (3->2) it emits a photon calculated to be 6.561E-07 meters, a difference of 0.026% from the measured value. All other calculations for orbitals were 0.025% from the measured value.

| **Orbital (N) Transition** | **3->2** | **4->2** | **5->2** | **6->2** | **7->2** | **8->2** | **9->2** |
|---|---|---|---|---|---|---|---|
| **Wavelength (Calculated) - meters** | **6.561E-07** | **4.860E-07** | **4.339E-07** | **4.101E-07** | **3.969E-07** | **3.888E-07** | **3.834E-07** |
| Wavelength (Measured) - meters | 6.563E-07 | 4.861E-07 | 4.340E-07 | 4.102E-07 | 3.970E-07 | 3.889E-07 | 3.835E-07 |
| *% Difference* | *0.026%* | *0.025%* | *0.025%* | *0.025%* | *0.025%* | *0.025%* | *0.025%* |

**Table 1.4 – Hydrogen Photon Wavelengths (Orbital Transition)** [5]

**Helium Photon Energy (Ionization)**

Helium shows an example of the Transverse Energy Equation and Amplitude Factor Equation, used to calculate photon energies during orbital transition or ionization. Two examples are provided for helium. In the first orbital (N=1), standard helium (He) is calculated to require a photon with energy of -3.88E-18 joules, a difference of 1.621% from the measured result. However, ionized helium (He+) yields better results with energy calculations at 0.042% difference against measured results for four of the first five orbitals.

| **Shell *(n)*** | **18,779** | **75,115** | **169,010** | **300,462** | **469,472** | **676,039** | **920,164** |
|---|---|---|---|---|---|---|---|
| Orbital (N) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | | | **Helium (He)** | | | | |
| **Energy (Calculated) - J** | **-3.88E-18** | **-9.69E-19** | **-4.31E-19** | **-2.42E-19** | **-1.55E-19** | **-1.08E-19** | **-7.91E-20** |
| Energy (Measured) - J | -3.94E-18 | | | | | | |
| *% Difference* | *1.621%* | | | | | | |
| | | | | | | | |
| | | | **He+** | | | | |
| **Energy (Calculated) - J** | **-8.72E-18** | **-2.18E-18** | **-9.69E-19** | **-5.45E-19** | **-3.49E-19** | **-2.42E-19** | **-1.78E-19** |
| Energy (Measured) - J | -8.72E-18 | -2.18E-18 | -9.68E-19 | -5.45E-19 | -3.49E-19 | | |
| *% Difference* | *-0.042%* | *-0.042%* | *-0.115%* | *-0.042%* | *-0.042%* | | |

**Table 1.5 – Helium Photon Energy**[6 7]

**Elements H to Ca - Photon Energy (Ionization)**

Similar to helium, ionization energies were calculated for the first twenty elements up to calcium. The first seven elements are shown in Table 1.6 and the remainder are shown later in Section 2.6. Using the Transverse Energy Equation and the Amplitude Factor Equation, the ionization energies of the following were calculated in MJ per mole:

- **Ionization Energy of $1s^2$ Electron of a Neutral Element** – Removal of an electron in the 1s subshell of a neutral element based on photoelectron spectroscopy results. The calculations vary from 0.04% to 2.66% from the measurements, likely due to the complexity of multiple electrons in the atoms to factor into the results.[8]
- **Ionization Energy of $1s^2$ Electron of an Ionized Element** – Removal of the $2^{nd}$ electron in an element that is ionized to have only two electrons in the 1s shell. Does not apply to hydrogen that has one electron. The calculations vary from 1.22% to 2.14% in difference, also likely due to the complexity of multiple electrons that factor into the results.[9]
- **Ionization Energy of $1s^1$ Electron of an Ionized Element** – Removal of the $1^{st}$ and only electron in an element that is ionized to only have one electron in the 1s shell. The calculations vary from 0.00% to 0.06% against measurements, better results than above, due to the fact that only one electron exists in each of these elements.[10]

| Element | H | He | Li | Be | B | C | N |
|---|---|---|---|---|---|---|---|
| **Ionization Energy of 1s2 Electron** | | | | | | | |
| **Energy (Calculated) - MJ/Mol** | **1.31** | **2.33** | **6.16** | **11.81** | **19.29** | **28.59** | **39.71** |
| Energy (Measured) - MJ/Mol | 1.31 | 2.37 | 6.26 | 11.50 | 19.30 | 28.60 | 39.60 |
| *% Difference* | *-0.21%* | *1.55%* | *1.58%* | *-2.66%* | *0.05%* | *0.04%* | *-0.28%* |
| | | | | | | | |
| **Ionization Energy of 1s2 Electron- Ionized Element** | | | | | | | |
| **Energy (Calculated) - MJ/Mol** | | **2.33** | **7.15** | **14.59** | **24.65** | **37.34** | **52.66** |
| Energy (Measured) - MJ/Mol | | 2.37 | 7.30 | 14.80 | 25.00 | 37.80 | 53.30 |
| *% Difference* | | *1.55%* | *2.14%* | *1.47%* | *1.42%* | *1.23%* | *1.22%* |
| | | | | | | | |
| **Ionization Energy of 1s1 Electron - Ionized Element** | | | | | | | |
| **Energy (Calculated) - MJ/Mol** | **1.31** | **5.25** | **11.81** | **21.00** | **32.82** | **47.26** | **64.32** |
| Energy (Measured) - MJ/Mol | 1.31 | 5.25 | 11.82 | 21.01 | 32.83 | 47.28 | 64.36 |
| *% Difference* | *-0.06%* | *-0.01%* | *0.00%* | *0.01%* | *0.02%* | *0.04%* | *0.05%* |

**Table 1.6 – Other Elements - Photon Energy**

**The Aether**

This view of particle formation and their interactions, based on waves, is admittedly very different than the current explanation and energy equations used today. Most importantly, it reintroduces the aether as the medium for propagating energy waves and calculates a density for the aether. In 1887, the Michelson-Morley experiment produced a negative result for the calculation of the aether and it has not been accepted since.[11]

The calculations in this paper are consistent with a density of a medium for propagating energy waves, thus to reintroduce the aether, the Michelson-Morley experiment must also be explained. One potential explanation for the negative result of the experiment is the neglect to consider length contraction in the experiment apparatus. Since another author provides this explanation, more information and details have been included in the Appendix of this paper.

## 1.1. Energy Wave Equation Constants

Before the energy wave equations are introduced, the notation, constants and variables that are used in the equations are provided.

**Notation**

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

| Notation | Meaning |
|---|---|
| $K_e$ | e – electron (wave center count) |
| $\lambda_l\ \lambda_t$ | l – longitudinal wave, t – transverse wave |
| $\Delta_e\ \Delta_{Ge}\ \Delta_T$ | 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) |
| $\lambda_{t(K,n)}$ | Transverse wavelength at particle wave center count (K) and shell (n) |

**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. Orbitals have been renamed to a capitalized N signifying that they are a subset of wavelength shells (n) at certain distances from the particle core.

| Symbol | Definition | Value (units) |
|---|---|---|
| | **Wave Constants** | |
| $A_l$ | Amplitude (longitudinal) | $3.662796647 \times 10^{-10}$ (m) |
| $\lambda_l$ | Wavelength (longitudinal) | $2.817940327 \times 10^{-17}$ (m) |
| $\rho$ | Density (aether) | $9.422369691 \times 10^{-30}$ (kg/m$^3$) |
| c | Wave velocity (speed of light) | 299,792,458 (m/s) |
| | **Variables** | |
| $\delta$ | Amplitude factor | variable - (m$^3$) |
| K | Particle wave center count | variable - *dimensionless* |
| n | Particle shells | variable - *dimensionless* |
| N | Particle orbits *(formerly n)* | variable - *dimensionless* |
| Q | Particle count in a group | variable - *dimensionless* |
| | **Electron Constants** | |
| $K_e$ | Particle wave center count - electron | 10 - *dimensionless* |
| | **Derived Constants*** | |
| $O_e$ | Shell energy multiplier – electron | 2.138743820 – *dimensionless* |
| $\Delta_e$ / $\delta_e$ | Orbital g-factor /amp. factor electron | 0.993630199 – *dimensionless* / (m$^3$) |

| | | |
|---|---|---|
| $\Delta_{Ge}/\delta_{Ge}$ | Spin g-factor/amp. gravity electron | 0.982746784 – *dimensionless* / ($m^3$) |
| $\Delta_T$ | Total angular momentum g-factor | 0.976461436 – *dimensionless* |
| $\alpha_e$ | Fine structure constant | 0.007297353– *dimensionless* |
| $\alpha_{Ge}$ | Gravity coupling constant - electron | 2.400531449 x $10^{-43}$ - *dimensionless* |

**Table 1.1.2 – Energy Wave Equation Constants and Variables**

**The derivations for the constants are:**

The shell energy 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).

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(1.1.1)}$$

The three modifiers ($\Delta$) are similar to the g-factors in physics. The value of $\Delta_{Ge}$ was adjusted slightly by 0.0000606 to match experimental data. Since $\Delta_T$ is derived from $\Delta_{Ge}$ it also required an adjustment, although slightly smaller at 0.0000581. 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 ($\alpha_e$) is used in the derivation in Eq. 1.1.2 as the correction factor is set against a well-known value.

$$\Delta_e = \delta_e = \frac{3\pi\lambda_l K_e^4}{A_l \alpha_e} \quad \textbf{(1.1.2)}$$

$$\Delta_{Ge} = \delta_{Ge} = 2A_l^3 K_e^{28} \quad \textbf{(1.1.3)}$$

$$\Delta_T = \Delta_e \Delta_{Ge} \quad \textbf{(1.1.4)}$$

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

$$\alpha_e = \frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e} \quad \textbf{(1.1.5)}$$

The gravitational coupling constant for the electron can also be derived. $\alpha_{Ge}$ 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 ($\alpha_G$ = 1.7 x $10^{-45}$). The derivation matches known calculations as $\alpha_{Ge} = \alpha_G / \alpha_e$ = 2.40 x $10^{-43}$.

$$\alpha_{Ge} = \frac{K_e^8 \lambda_l^7 \delta_e}{\pi A_l^7 O_e \delta_{Ge}} \tag{1.1.6}$$

## 1.2. Energy Wave Equations

There are two forms of the energy wave: longitudinal and transverse. Detailed calculations using energy wave equations for both of these waveforms are provided in Section 2 and the explanations and derivations are provided in Section 3.

For the purpose of understanding the energy wave equations in this section, it is accepted that there is an aether and that it consists of two things: 1) granules that are the fabric of space and transmit a wave, and 2) wave centers that reflect a wave. Further, it assumes that particles are created from wave centers in formation that consist of longitudinal in-waves and out-waves. Finally, particle motion, particularly a vibration, creates a transverse wave. In wave theory, the following laws govern energy waves and particle formation:

**Wave Theory Laws**

1. Energy waves travel throughout the aether at a defined wave speed and wavelength as wavelets to form a wavefront according to Huygen's principle.[12] Amplitude is reduced at the square of distance from the source and experiences constructive and destructive wave interference.
2. Aether granules are the medium that can respond to a wave such that it can pass its inertia and momentum to the next granule. It may have a memory to understand its state, which holds a defined amount of energy.
3. Aether wave centers reflect longitudinal waves and may assemble in formation to create particles via constructive and destructive wave interference.
4. Aether wave centers move to minimize amplitude on the wave, thereby preferring the node position of the wave.
5. Wave energy is proportional to amplitude, wavelength, wave speed and density of a defined volume.

**Energy Wave Equations**

$$E_{l(K)} = \frac{4\pi \boldsymbol{\rho} K^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \tag{1.2.1}$$

**Longitudinal Energy Equation**

$$E_{t\,(K,\,n_f - n_i)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{A_l} \left(\frac{1}{n_f} - \frac{1}{n_i}\right) \tag{1.2.2}$$

**Transverse Energy Equation**

$$\lambda_{t\,(K,\,n_f - n_i)} = \frac{4A_l}{3K^2} \frac{1}{\left(\frac{1}{n_f} - \frac{1}{n_i}\right)} (\Delta_e) \tag{1.2.3}$$

**Transverse Wavelength Equation**

$$n_N = \left(\frac{N}{\alpha_e}\right)^2 \tag{1.2.4}$$

**Orbital Equation**

$$\delta = \left(Z - \frac{4}{3}\left(\frac{(N1e - 1)}{2} + \frac{N2e}{8} + \frac{1}{2}\left(\frac{N3e}{8}\right) + \frac{1}{3}\left(\frac{N4e}{8}\right)\right)\right)^2 \tag{1.2.5}$$

**Amplitude Factor Equation – 1s Orbital Ionization**

The Amplitude Factor Equation (1s Orbital Ionization) works for the ionization energy up to the first twenty elements, calcium (Z=20), of the first orbital. Z is the number of protons, and N1e, N2e, N3e, and N4e are the number of electrons in orbital shell N=1 (1s orbital), N=2 (2s, 2p orbitals), N=3 (3s, 3p orbitals) and N=4 (4s, 4p orbitals) respectively. Note the sequence 2, 8, 8, 8 in the denominators that match the orbital shells.

Energy calculations are in joules (J) and wavelength in meters (m) unless otherwise specified.

# 2. Calculations

This section details the steps to reproduce the calculations and comparisons against measured results in Section 1, using the energy wave equations and constants also provided in the same section. Explanations of the energy wave equations are reserved for Section 3.

## 2.1. Rest Energy of Leptons

The Longitudinal Energy Equation (Eq. 1.2.1) was used to calculate the rest energy of lepton particles (the neutrino and electron particle families). Each particle is assumed to consist of wave centers, which is given the variable K to describe the unique wave center count for each type of particle. These results are provided in Table 1.1 for each value of K.

For example, a particle with one wave center count (K=1) closely resembles the neutrino particle. Note that the neutrino has a difficult mass to measure and a value of 2.2 eV is used from Standard Model Table.[13] This is compared against a calculated value of 3.8280E-14 joules, or 2.4 eV.

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

**Calculated Value:** 3.8280E-14 joules (kg m$^2$/s$^2$)
**Difference from Neutrino Estimate:** 8.60%

The electron was calculated at a wave center count at K=10. As this value of K appears in many equations related to the electron, it is given a special electron constant, $K_e$. At $K_e$ = 10, a value of 8.1871E-14 joules is calculated, which is no difference (0.000%) to that level of digits from the CODATA value of the electron in joules.

$$E_e = E_{l(10)} = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(2.1.2)}$$

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

***Note:*** With the exception of the proton and neutron, which are already known to consist of smaller particles (thought to be quarks), the leptons are particles that appear in nature, even if they rapidly oscillate or decay into other particles. Other particles that are created in particle accelerator labs, including the Higgs boson, were calculated but placed into the Appendix for reference since these particles have very different characteristics than leptons.

## 2.2. Hydrogen Orbital Distances

The orbital distances for hydrogen in Table 1.2 were calculated with the Orbital Equation (Eq. 1.2.4). This equation matches the results of the Bohr radius (first orbital) with 0.00% difference and furthermore it is assumed that the values of the remaining orbitals are also accurate otherwise the photon wavelengths and energies in Tables 1.3 to 1.5 would not have been accurate.

The following example calculates the first two orbitals (N) in terms of wavelengths (n) and meters. The fine structure constant ($\alpha_e$) is derived in terms of wave constants in *Fundamental Physical Constants*[14], but for simplicity of this equation, its well-known value is used here. Eq. 2.2.1 is solved for the first orbital, N=1.

$$n_N = \left(\frac{N}{\alpha_e}\right)^2 \quad \textbf{(2.2.1)}$$

**N=1**
$\boldsymbol{\alpha_e}$ = Fine Structure Constant = 7.29735257 x $10^{-3}$
**Calculated Value Wavelengths (n):** 18,779

To represent wavelengths in meters, it is converted using the number of wavelengths above (18,779) multiplied by the electron radius ($K^2 \lambda$). Units are in meters. The calculation for the first orbital matches the CODATA value for the Bohr radius with no difference (0.000%).

$$r_N = n_N K_e^2 \lambda_l \quad \textbf{(2.2.2)}$$

**N=1**
**Calculated Value Meters (m):** 5.2918E-11
**Difference from CODATA (Bohr Radius):** 0.000%

The same equations (Eq. 2.2.1 and 2.2.2) are now used to solve N=2 for the second orbital. It is represented in both wavelengths and meters by replacing N with the value 2. This can be repeated for each of the orbitals for hydrogen (e.g. N=3, N=4, N=5, etc).

**N=2**
**Calculated Value Wavelengths (n):** 75,115
**Calculated Value Meters (m):** 2.1167E-10

## 2.3. Hydrogen Photon Wavelength (Ionization)

In Table 1.3, the wavelengths of absorbed photons for hydrogen were calculated at differing orbitals when the atom is ionized (electron leaves the atom from orbital N). The traditional orbitals are represented as integers in the variable N, and the wavelengths, or subshells, are represented by the variable n. Using Table 1.2, the wavelengths (n) are found for each orbital (N). For example, the first orbital (N=1) will be calculated below. In N=1, there are n=18,779 wavelengths.

To find photon wavelengths, the Transverse Wavelength Equation is used (Eq. 1.2.3). In the case of ionization, this equation can be simplified. The electron is ejected from the atom so the final position ($n_f$) can be replaced by infinity in the equation. This is represented in Eq. 2.3.1. Since the value of K is solving for the electron, it is K=10, or simply $K_e$.

Eq. 2.3.1 is simplified to become a variation of the Transverse Wavelength Equation for ionization in Eq. 2.3.3. When a single electron is calculated there is a slight deviation in the calculations that is corrected by the modifier ($\Delta_e$). The modifier is the same value as the amplitude factor for the electron ($\delta_e$), but it is a dimensionless version. It was also used in many of the constants calculated in *Fundamental Physical Constants* so it is believed to correct assumptions in the equations related to volume, in which volumes for particles assumed perfect spheres and photons assumed perfect cylindrical volumes.

In the first orbital, N=1 or n=18,779, a value of 9.113E-8 meters is calculated for the wavelength of hydrogen ionization, a difference of 0.004% from measured results.

$$\lambda_{t(K_e,\infty - n_i)} = \frac{4A_l}{3K_e^2}\frac{1}{\left(\frac{1}{\infty} - \frac{1}{n_i}\right)}(\Delta_e) \quad \textbf{(2.3.1)}$$

$$\lambda_{t(K_e,\infty - n_i)} = \frac{4A_l}{3K_e^2}\frac{1}{\left(0 - \frac{1}{n_i}\right)}(\Delta_e) \quad \textbf{(2.3.2)}$$

$$\lambda_{t(K_e,n_i)} = \frac{(-4)\,n_i A_l}{3K_e^2}(\Delta_e) \quad \textbf{(2.3.3)}$$

**Transverse Wavelength Equation – Electron Ionization**

**$n_i$ =** 18,779
**Calculated Value:** -9.113E-8 meters (m)
**Difference from Measured Result:** 0.004%

## 2.4. Hydrogen Photon Wavelength (Orbital Transition)

Similar to Section 2.3, the wavelengths of photons emitted or absorbed can be calculated using the Transverse Wavelength Equation (Eq. 1.2.3). In this example, an electron changes orbitals but does not leave the atom in the case of ionization. When the electron transitions to a lower shell, it emits a photon. The calculation in this case yields a positive result, noting that a photon is emitted. When a photon is absorbed and the electron transitions to a higher shell or is ejected from the atom (ionization), the calculation yields a negative result, as seen in Section 2.3.

Table 1.4 contains calculations of electron transitions from various orbitals to the second orbital (N=2). An example calculation is provided below, as an example of transitioning from the third orbital (N=3) to the second orbital (N=2). This is represented by: 3->2.

Using Table 1.2, the third orbital (N=3) has 169,010 wavelengths and the second orbital (N=2) has 75,115 wavelengths. These are used as the values $n_i$ and $n_f$ respectively. The resulting calculation is 6.561E-7 meters, or a difference of 0.026% from the measured result.

$$\lambda_{t\,(K_e,\,75115\,-\,169010)} = \frac{4A_l}{3K_e^2} \frac{1}{\left(\frac{1}{n_f} - \frac{1}{n_i}\right)} (\Delta_e) \tag{2.4.1}$$

$$\lambda_{t\,(K_e,\,75115\,-\,169010)} = \frac{4A_l}{3K_e^2} \frac{1}{\left(\frac{1}{75115} - \frac{1}{169010}\right)} (\Delta_e) \tag{2.4.2}$$

**3->2**
**$n_i$ =** 169,010
**$n_f$ =** 75,115
**Calculated Value:** 6.561E-7 meters (m)
**Difference from Measured Result:** 0.026%

## 2.5. Helium Photon Energy (Ionization)

Energy levels of photons are calculated using the Transverse Energy Equation (Eq. 1.2.2). In Table 1.5, two calculations are provided for helium (He) and ionized helium (He+). Although the same equation is used to calculate photon energy, amplitude factor is variable. Thus, the Amplitude Factor Equation (Eq. 1.2.5) is also used in these calculations to determine the amplitude factor for elements other than hydrogen. The amplitude factor is the constructive and destructive wave interference from multiple protons in the nucleus (Z) and surrounding electrons in the atom that affect wave amplitude.

First, these amplitude factors are calculated for He and He+ using the Amplitude Factor Equation (Eq. 1.2.5), shown again in Eq. 2.5.1. Z is the number of protons, N1e is the number of electrons in the first orbital (N=1), N2e is the number of electrons in the second orbital (N=2), etc. Standard helium has 2 protons and 2 electrons. It is calculated in Eq. 2.5.2.

$$\delta = \left(Z - \frac{4}{3}\left(\frac{(N1e-1)}{2} + \frac{N2e}{8} + \frac{1}{2}\left(\frac{N3e}{8}\right) + \frac{1}{3}\left(\frac{N4e}{8}\right)\right)\right)^2 \qquad \textbf{(2.5.1)}$$

$$\delta_{He} = \left(2 - \frac{4}{3}\left(\frac{(2-1)}{2} + \frac{0}{8} + \frac{1}{2}\left(\frac{0}{8}\right) + \frac{1}{3}\left(\frac{0}{8}\right)\right)\right)^2 \qquad \textbf{(2.5.2)}$$

**Helium (He)**
**Z =** 2 (protons)
**N1e =** 2 (electrons)
$\boldsymbol{\delta}_{\mathbf{He}}$ = 1.77778

Similarly, for ionized helium (He+) with two protons and one electron:

$$\delta_{He``+"} = \left(2 - \frac{4}{3}\left(\frac{(1-1)}{2} + \frac{0}{8} + \frac{1}{2}\left(\frac{0}{8}\right) + \frac{1}{3}\left(\frac{0}{8}\right)\right)\right)^2 \qquad \textbf{(2.5.3)}$$

**Ionized Helium (He+)**
**Z = 2** (protons)
**N1e = 1** (electrons)
$\boldsymbol{\delta}_{\mathbf{He+}}$ = 4.0

Photon ionization energy is similar to the calculation for wavelength ionization. As the electron is ejected, the final position is set to infinity as shown in Eq. 2.5.4. It is simplified to the Transverse Energy Equation for Electron Ionization in Eq. 2.5.6.

$$E_{t\,(K_e,\,\infty - n_i)} = \frac{2\pi\rho K_e^5 \lambda_l c^2 \delta}{A_l}\left(\frac{1}{\infty} - \frac{1}{n_i}\right) \qquad \textbf{(2.5.4)}$$

$$E_{t(K_e, n_i)} = \frac{2\pi\rho K_e^5 \lambda_l c^2 \delta}{A_l} \left(0 - \frac{1}{n_i}\right) \quad \textbf{(2.5.5)}$$

$$E_{t(K_e, n_i)} = \frac{-2\pi\rho K_e^5 \lambda_l c^2 \delta}{A_l} \quad \textbf{(2.5.6)}$$

**Transverse Energy Equation – Electron Ionization**

Now that the amplitude factors are known, photon energies can be calculated using Eq. 2.5.6. Two example calculations are provided for the first orbital, since the Orbital Equation works only for the 1s subshell. N=1 has 18,779 wavelengths according to Table 1.2. This value is used along with the amplitude factors below.

$$E_{t(K_e, n_i)} = \frac{(-2)\,\pi\rho K_e^5 \lambda_l c^2 \delta_{He}}{n_i A_l} \quad \textbf{(2.5.7)}$$

**Helium (He)**
**$n_i$ =** 18,779
**$\delta_{He}$ =** 1.77778
**Calculated Value:** -3.88E-18 joules
**Difference from Measured Result:** 1.621%

Similarly, ionized helium is calculated at the first orbital for ionization energy, but using the amplitude factor for ionized helium. The amplitude factor is higher and the energy is greater because there are two protons, but no other electrons, that affect wave construction.

$$E_{t(K_e, n_i)} = \frac{(-2)\,\pi\rho K_e^5 \lambda_l c^2 \delta_{He``+"}}{n_i A_l} \quad \textbf{(2.5.8)}$$

**Helium (He+)**
**$n_i$ =** 18,779
**$\delta_{He+}$ =** 4.0
**Calculated Value:** -8.72E-18 joules
**Difference from Measured Result:** -0.042%

## 2.6. Elements H to Ca – Photon Energy (Ionization)

In Table 1.6, other elements beyond hydrogen and helium were calculated for the ionization photon energy in the first orbital. This section goes beyond the results displayed in Table 1.6 to calculate the first twenty elements, from hydrogen to calcium. Beyond calcium, the Amplitude Factor Equation does not work within a reasonable accuracy as electrons begin to fill the 3d subshell.

Table 1.6 shows three types of calculations. Because the Amplitude Factor Equation is designed for the first subshell, 1s, there are three types of calculations provided for different arrangements of atoms:

- **Ionization Energy of $1s^2$ Electron** – Removal of the 2nd electron in the 1s subshell in a standard element from a neutral element, matching photoelectron spectroscopy data.
- **Ionization Energy of $1s^2$ Electron of an Ionized Element** – Removal of the 2nd electron in an element that is ionized to only have two electrons (located in the 1s subshell).
- **Ionization Energy of $1s^1$ Electron of an Ionized Element** – Removal of the 1st and only electron in an element that is ionized to only have one electron (located in the 1s subshell).

An illustration of these three types is as follows:

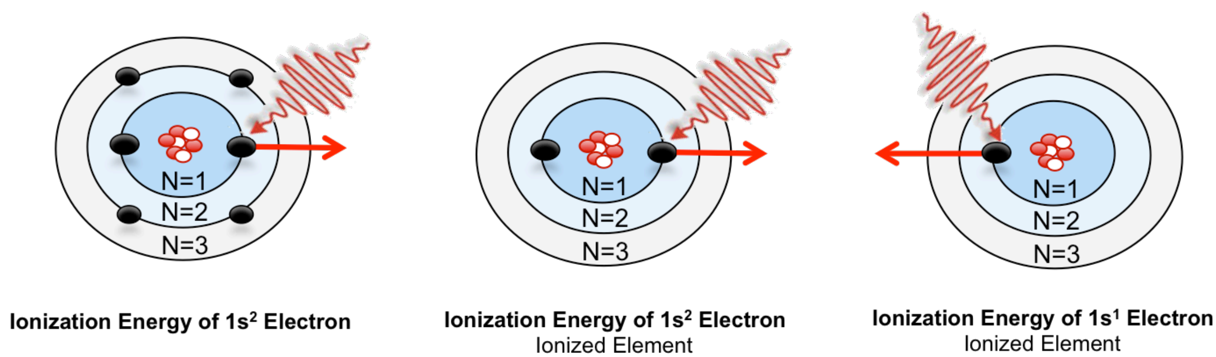



**Fig. 2.6.1 – Electron Ionization and Amplitude Factors**

**Ionization Energy of 1s2 Electron**

The process is identical to Section 2.5 that describes the calculation of helium ionization energy. Helium is seen again in Table 2.6.1, with the calculation in joules (third to last column) and in megajoules per mole (MJ/Mol in the second to last column). The calculation in MJ/Mol is compared to the measured results in MJ/Mol in the last column.

| Element | Protons | Electrons (N1) | Electrons (N2) | Electrons (N3) | Electrons (N4) | Amp Factor (δ) 1s2 Orbital | Energy J (calc) | -MJ/Mol (calc) | MJ/Mol |
|---|---|---|---|---|---|---|---|---|---|
| H | 1 | 1 | 0 | 0 | 0 | 1.000 | -2.18E-18 | **1.31** | *1.31* |
| He | 2 | 2 | 0 | 0 | 0 | 1.778 | -3.88E-18 | **2.33** | *2.37* |
| Li | 3 | 2 | 1 | 0 | 0 | 4.694 | -1.02E-17 | **6.16** | *6.26* |
| Be | 4 | 2 | 2 | 0 | 0 | 9.000 | -1.96E-17 | **11.8** | *11.5* |
| B | 5 | 2 | 3 | 0 | 0 | 14.69 | -3.20E-17 | **19.3** | *19.3* |
| C | 6 | 2 | 4 | 0 | 0 | 21.78 | -4.75E-17 | **28.6** | *28.6* |
| N | 7 | 2 | 5 | 0 | 0 | 30.25 | -6.59E-17 | **39.7** | *39.6* |
| O | 8 | 2 | 6 | 0 | 0 | 40.11 | -8.74E-17 | **52.7** | *52.6* |
| F | 9 | 2 | 7 | 0 | 0 | 51.36 | -1.12E-16 | **67.4** | *67.2* |
| Ne | 10 | 2 | 8 | 0 | 0 | 64.00 | -1.40E-16 | **84.0** | *84.0* |
| Na | 11 | 2 | 8 | 1 | 0 | 79.51 | -1.73E-16 | **104.4** | *104* |
| Mg | 12 | 2 | 8 | 2 | 0 | 96.69 | -2.11E-16 | **126.9** | *126* |
| Al | 13 | 2 | 8 | 3 | 0 | 115.6 | -2.52E-16 | **151.7** | *151* |
| Si | 14 | 2 | 8 | 4 | 0 | 136.1 | -2.97E-16 | **178.7** | *178* |
| P | 15 | 2 | 8 | 5 | 0 | 158.3 | -3.45E-16 | **207.9** | *208* |
| S | 16 | 2 | 8 | 6 | 0 | 182.3 | -3.97E-16 | **239.2** | *239* |
| Cl | 17 | 2 | 8 | 7 | 0 | 207.8 | -4.53E-16 | **272.8** | *273* |
| Ar | 18 | 2 | 8 | 8 | 0 | 235.1 | -5.13E-16 | **308.6** | *309* |
| K | 19 | 2 | 8 | 8 | 1 | 265.0 | -5.78E-16 | **347.8** | *347* |
| Ca | 20 | 2 | 8 | 8 | 2 | 296.6 | -6.47E-16 | **389.4** | *390* |

**Table 2.6.1 – Ionization Energies – 1s2 Electron – Standard Elements H through Ca**

An example calculation is calcium with 20 protons and 20 electrons. The electrons are distributed to 2 electrons in N=1, 8 electrons in N=2, 8 electrons in N=3 and 2 electrons in N=4. The amplitude factor is calculated as follows:

$$\delta_{Ca} = \left(20 - \frac{4}{3}\left(\frac{(2-1)}{2} + \frac{8}{8} + \frac{1}{2}\left(\frac{8}{8}\right) + \frac{1}{3}\left(\frac{2}{8}\right)\right)\right)^2 \qquad \textbf{(2.6.1)}$$

**Calcium (Ca)**
**Z = 20** (protons)
**N1e = 2** (electrons)
**N2e = 8** (electrons)
**N3e = 8** (electrons)
**N4e = 2** (electrons)
$\boldsymbol{\delta_{Ca}}$ = 296.6

The value 296.6 can be found in Table 2.6.1 as the amplitude factor for calcium. Also found in the table is the energy calculation using the Transverse Energy Equation – Electron Ionization form, using the first orbital where $n_i$=18,779 wavelengths.

$$E_{t(K_e, n_i)} = \frac{(-2)\,\pi\rho K_e^5 \lambda_l c^2 \delta_{Ca}}{n_i A_l} \qquad \textbf{(2.6.2)}$$

**Calcium (Ca)**
$\mathbf{n_i}$ = 18,779

$\delta_{Ca}$ = 296.6
**Calculated Value:** -6.47E-16 joules

Since the measured results are in megajoules per mole (MJ/mol), the calculated value in joules needs to be converted using Avogadro's constant (6.022 x $10^{23}$) and by converting joules to megajoules by dividing by 1 x $10^6$. After the conversion, the resulting calculation is 389.4 MJ/mol, which is a difference of 0.162% from the measured value.

$$E_{t\,(10,\,18779)} = \frac{-6.47\cdot 10^{-16}\,(6.022\cdot 10^{23})}{1\times 10^{6}} \qquad \textbf{(2.6.3)}$$

**Calcium (Ca)**
**Calculated Value:** (-) 389.4 MJ/mol
**Difference from Measured Result:** 0.162%

### Ionization Energy of 1s2 Electron – Ionized Element

Proof that the difference between ionization energies is simply a difference in amplitude is further expressed by calculating the amplitude factors for the first twenty elements without electrons in the outer orbitals, beyond the first orbital (1s). In table 2.6.2, elements from hydrogen to calcium have been calculated, but many of these elements (beyond helium) are ionized such that they only have two electrons. The same process is used, calculating the amplitude factor and then the energy calculation using the Transverse Energy Equation. But the effect of fewer electrons is apparent in the amplitude factor. The ionization energy associated with the photon that is required to be absorbed is calculated in joules, then converted to MJ/Mol (second to last column) and finally compared to the measured results in MJ/Mol (last column).

| Element | Protons | Electrons (N1) | Electrons (N2) | Electrons (N3) | Electrons (N4) | Amp Factor (δ) 1s2* Orbital | Energy J (calc) | -MJ/Mol (calc) | MJ/Mol |
|---|---|---|---|---|---|---|---|---|---|
| **H** | 1 | 1 | 0 | 0 | 0 | | | | |
| **He** | 2 | 2 | 0 | 0 | 0 | 1.7778 | -3.88E-18 | **2.33** | *2.37* |
| **Li 1+** | 3 | 2 | 0 | 0 | 0 | 5.4444 | -1.19E-17 | **7.15** | *7.3* |
| **Be 2+** | 4 | 2 | 0 | 0 | 0 | 11.111 | -2.42E-17 | **14.6** | *14.8* |
| **B 3+** | 5 | 2 | 0 | 0 | 0 | 18.778 | -4.09E-17 | **24.7** | *25.0* |
| **C 4+** | 6 | 2 | 0 | 0 | 0 | 28.444 | -6.20E-17 | **37.3** | *37.8* |
| **N 5+** | 7 | 2 | 0 | 0 | 0 | 40.111 | -8.74E-17 | **52.7** | *53.3* |
| **O 6+** | 8 | 2 | 0 | 0 | 0 | 53.778 | -1.17E-16 | **70.6** | *71.3* |
| **F 7+** | 9 | 2 | 0 | 0 | 0 | 69.444 | -1.51E-16 | **91.2** | *92* |
| **Ne 8+** | 10 | 2 | 0 | 0 | 0 | 87.111 | -1.90E-16 | **114.4** | *115* |
| **Na 9+** | 11 | 2 | 0 | 0 | 0 | 106.78 | -2.33E-16 | **140.2** | *141* |
| **Mg 10+** | 12 | 2 | 0 | 0 | 0 | 128.44 | -2.80E-16 | **168.6** | *169* |
| **Al 11+** | 13 | 2 | 0 | 0 | 0 | 152.11 | -3.32E-16 | **199.7** | *201* |
| **Si 12+** | 14 | 2 | 0 | 0 | 0 | 177.78 | -3.88E-16 | **233.4** | *235* |
| **P 13+** | 15 | 2 | 0 | 0 | 0 | 205.44 | -4.48E-16 | **269.7** | *271* |
| **S 14+** | 16 | 2 | 0 | 0 | 0 | 235.11 | -5.13E-16 | **308.6** | *311* |
| **Cl 15+** | 17 | 2 | 0 | 0 | 0 | 266.78 | -5.82E-16 | **350.2** | *353* |
| **Ar 16+** | 18 | 2 | 0 | 0 | 0 | 300.44 | -6.55E-16 | **394.4** | *398* |
| **K 17+** | 19 | 2 | 0 | 0 | 0 | 336.11 | -7.33E-16 | **441.2** | *445* |
| **Ca 18+** | 20 | 2 | 0 | 0 | 0 | 373.78 | -8.15E-16 | **490.7** | *495* |

**Table 2.6.2 – Ionization Energies – 1s2 Electron – Ionized Elements H through Ca**

An example calculation is heavily ionized neon (Ne) with 10 protons and 2 electrons. The electrons are distributed to 2 electrons in N=1. The amplitude factor is calculated as follows:

$$\delta_{Ne``8+"} = \left(10 - \frac{4}{3}\left(\frac{(2-1)}{2} + \frac{0}{8} + \frac{1}{2}\left(\frac{0}{8}\right) + \frac{1}{3}\left(\frac{0}{8}\right)\right)\right)^2 \quad \textbf{(2.6.4)}$$

**Neon (Ne8+)**
**Z = 10** (protons)
**N1e = 2** (electrons)
$\boldsymbol{\delta_{Ne8+}}$ **=** 87.111

The value 87.111 can be found in Table 2.6.2 as the amplitude factor for heavily ionized neon with only two electrons. Also found in the table is the energy calculation using the Transverse Energy Equation – Electron Ionization form, using the first orbital where $n_i$=18,779 wavelengths. The conversion from joules to MJ/Mol is identical to the calcium example above and is not illustrated again.

$$E_{t\,(K_e,\,n_i)} = \frac{(-2)\,\pi\rho K_e^5\lambda_l c^2\delta_{Ne``8+"}}{n_i A_l} \quad \textbf{(2.6.5)}$$

**Neon (Ne8+)**
$\boldsymbol{n_i}$ **=** 18,779
$\boldsymbol{\delta_{Ne8+}}$ **=** 87.111
**Calculated Value (joules):** -1.90E-16 joules
**Calculated Value (MJ/Mol):** (-) 114.4 MJ/mol
**Difference from Measured Result:** 0.564%

**Ionization Energy of 1s1 Electron – Ionized Element**

The first orbital can also be calculated with only a single electron. Ionized helium (He+) was already calculated as an example in Section 2.5. The value of -8.72E-18 joules is shown again in Table 2.6.3 along with ionization energies of other heavily ionized elements. In all of these calculations, elements have only one electron that is then removed. The ionization energy associated with the photon that is required to be absorbed is calculated in joules, converted to MJ/Mol (second to last column) and then finally compared to the measured results in MJ/Mol (last column).

| Element | Protons | Electrons (N1) | Electrons (N2) | Electrons (N3) | Electrons (N4) | Amp Factor (δ) 1s1* Orbital | Energy J (calc) | -MJ/Mol (calc) | MJ/Mol |
|---|---|---|---|---|---|---|---|---|---|
| **H** | 1 | 1 | 0 | 0 | 0 | 1 | -2.18E-18 | **1.31** | *1.31* |
| **He 1+** | 2 | 1 | 0 | 0 | 0 | 4 | -8.72E-18 | **5.25** | *5.25* |
| **Li 2+** | 3 | 1 | 0 | 0 | 0 | 9 | -1.96E-17 | **11.8** | *11.8* |
| **Be 3+** | 4 | 1 | 0 | 0 | 0 | 16 | -3.49E-17 | **21.0** | *21.0* |
| **B 4+** | 5 | 1 | 0 | 0 | 0 | 25 | -5.45E-17 | **32.8** | *32.8* |
| **C 5+** | 6 | 1 | 0 | 0 | 0 | 36 | -7.85E-17 | **47.3** | *47.3* |
| **N 6+** | 7 | 1 | 0 | 0 | 0 | 49 | -1.07E-16 | **64.3** | *64.4* |
| **O 7+** | 8 | 1 | 0 | 0 | 0 | 64 | -1.40E-16 | **84.0** | *84.1* |
| **F 8+** | 9 | 1 | 0 | 0 | 0 | 81 | -1.77E-16 | **106.3** | *106* |
| **Ne 9+** | 10 | 1 | 0 | 0 | 0 | 100 | -2.18E-16 | **131.3** | *131* |
| **Na 10+** | 11 | 1 | 0 | 0 | 0 | 121 | -2.64E-16 | **158.8** | *159* |
| **Mg 11+** | 12 | 1 | 0 | 0 | 0 | 144 | -3.14E-16 | **189.0** | *189* |
| **Al 12+** | 13 | 1 | 0 | 0 | 0 | 169 | -3.68E-16 | **221.9** | *222* |
| **Si 13+** | 14 | 1 | 0 | 0 | 0 | 196 | -4.27E-16 | **257.3** | *258* |
| **P 14+** | 15 | 1 | 0 | 0 | 0 | 225 | -4.90E-16 | **295.4** | *296* |
| **S 15+** | 16 | 1 | 0 | 0 | 0 | 256 | -5.58E-16 | **336.1** | *337* |
| **Cl 16+** | 17 | 1 | 0 | 0 | 0 | 289 | -6.30E-16 | **379.4** | *381* |
| **Ar 17+** | 18 | 1 | 0 | 0 | 0 | 324 | -7.06E-16 | **425.3** | *427* |
| **K 18+** | 19 | 1 | 0 | 0 | 0 | 361 | -7.87E-16 | **473.9** | *476* |
| **Ca 19+** | 20 | 1 | 0 | 0 | 0 | 400 | -8.72E-16 | **525.1** | *528* |

**Table 2.6.3 – Ionization Energies – 1s1 Electron – Ionized Elements H through Ca**

An example calculation is doubly ionized lithium with 3 protons and 1 electron. The electron is distributed to one electron in N=1. The amplitude factor is calculated as follows:

$$\delta_{Li``2+"} = \left(3 - \frac{4}{3}\left(\frac{(1-1)}{2} + \frac{0}{8} + \frac{1}{2}\left(\frac{0}{8}\right) + \frac{1}{3}\left(\frac{0}{8}\right)\right)\right)^2 \qquad \textbf{(2.6.6)}$$

**Lithium (Li2+)**
**Z = 3** (protons)
**N1e = 1** (electrons)
$\delta_{Li2+}$ = 9.0

The value 9.0 can be found in Table 2.6.3 as the amplitude factor for doubly ionized lithium with only one electron. Also found in the table is the energy calculation using the Transverse Energy Equation – Electron Ionization form, using the first orbital where $n_i$=18,779 wavelengths. The conversion from joules to MJ/Mol is identical to the calcium example above and is not illustrated again.

$$E_{t(K_e, n_i)} = \frac{(-2)\,\pi\rho K_e^5 \lambda_l c^2 \delta_{Li``2+"}}{n_i A_l} \qquad \textbf{(2.6.7)}$$

**Lithium (Li2+)**
**$n_i$ =** 18,779
$\delta_{Li2+}$ = 9.0
**Calculated Value (joules):** -1.96E-17 joules
**Calculated Value (MJ/Mol):** (-) 11.8 MJ/mol
**Difference from Measured Result:** 0.002%

## 2.7. Electron Annihilation Energy

A very similar process can be used to determine the energy shell during particle annihilation. Rather than eject a particle, the particle (e.g. electron) is attracted to the point where it settles in a position near its attracting anti-matter counterpart (e.g. positron) where waves cancel and amplitude reaches zero. Eq. 2.7.1 is very similar to Eq. 2.5.2, with the exception of the initial and final starting positions of the particle. This difference leads to positive sign instead of negative sign in the equation, indicating that it creates a photon instead of requiring energy to be absorbed.

$$E_{t\,(K,\,n_f-\infty)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{A_l}\left(\frac{1}{n_f} - \frac{1}{\infty}\right) \tag{2.7.1}$$

$$E_{t\,(K,\,n_f-\infty)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{A_l}\left(\frac{1}{n_f} - 0\right) \tag{2.7.2}$$

$$E_{t\,(K,\,n_f-\infty)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{n_f A_l} \tag{2.7.3}$$

**Transverse Energy Equation - Annihilation**

For example, annihilation of the electron and positron occurs at a half wavelength (n=0.5) where standing waves exactly cancel. This is also known as the anti-phase of the wave at a half wavelength. This was calculated using the energy of the known photon when an electron and positron annihilate, or 8.1871 x $10^{-14}$ joules. Using Eq. 2.7.3, energy is set to the photon energy and $n_f$ is isolated to obtain the final position of the electron, relative to the positron, after annihilation. The particles remain but due to destructive wave interference, they are not detected.

Note: the modifier ($\Delta_e$) is introduced in Eq. 2.7.5, which occurs in the transitions between longitudinal and transverse energies.

$$8.18711\times10^{-14} = \frac{2\pi\rho K_e^5 \lambda_l c^2 \delta_e}{n_{f_e} A_l} \tag{2.7.4}$$

$$n_{f_e} = \frac{2\pi\rho\delta_e\lambda_l c^2 K_e^5}{8.18711\times10^{-14} A_l}\Delta_e^{-1} \quad \textbf{(2.7.5)}$$

**$n_f$ = 0.**5 wavelengths

## 2.8. Electron Compton Wavelength

The Compton wavelength of the electron (2.43 x $10^{-12}$ m) can be calculated using the Transverse Wavelength Equation (Eq. 1.2.3). Similar to the annihilation energy in Section 2.7, the wavelength can be calculated using the wavelength shell (n) where the electron sits relative to the positron after annihilation. This is because the Compton wavelength is the photon energy equal to the rest energy of a particle. However, upon annihilation, there are two particles and two photons generated, such that one photon is equal to the rest energy of one of the particles. The value of 0.5 wavelengths calculated in Section 2.7 is used for $n_f$.

This indicates that the particles settle in a position where their longitudinal amplitudes completely cancel. There is no mass that can be measured because their standing waves have collapsed and have transferred energy to transverse energy (photons). However, the particles remain and their wave centers are still resonating at the same frequency – it is just that amplitude is zero or negligible. These particles may eventually be separated again with sufficient energy in the pair production process, which explains why an electron and positron can be created in a vacuum with a photon equal to or greater than the sum of its two masses.[15]

$$\lambda_C = \lambda_{t\,(10,\,0.5)} = \frac{4n_f A_l}{3K_e^2}(\Delta_e) \quad \textbf{(2.8.1)}$$

**$n_f$ = 0.**5 wavelengths
**Calculated Value:** 2.4263E-12 meters
**Difference from Measured Result:** 0.000%

# 3. Deriving and Explaining the Energy Wave Equations

In the previous sections, the energy wave equations were introduced, including their use and calculation of particle properties including rest energies, photon energies and transverse wavelengths. This section describes the derivation of these equations, explains why they work and how particles interact.

To begin, it is assumed that the energy in the universe, including particles, comes from a base wave energy equation in the following form. Frequency (f) is otherwise expressed as c / λ, which leads to Eq. 3.2.

$$E = \boldsymbol{\rho} V (f_l A_l)^2 \tag{3.1}$$

$$E = \boldsymbol{\rho} V \left(\frac{c}{\lambda} A\right)^2 \tag{3.2}$$

**Base Energy Wave Equation**

Before deriving the equations, it is important to understand the assumptions that were used to create the equations. Energy flows in waves, but there are two major forms of waves: longitudinal and transverse. Further, longitudinal waves may be standing or traveling. As particles are governed by these types of waveforms, an analogy may be helpful to understand how it works.

Imagine a balloon, under water in the middle of a pool, which is rapidly inflated and deflated repeatedly. The balloon will send spherical, longitudinal waves throughout the pool, losing energy proportional to the inverse square of the distance from the balloon. Now, imagine the balloon, while still being rapidly inflated and deflated, is also traveling up-and-down, from the bottom of the pool to the top and back again. This will create a secondary, transverse wave perpendicular to the motion – towards the sides of the pool.

Next, consider the balloon as the fundamental particle. There is nothing that is smaller than the balloon. It is the wave center and responsible for creating waves that travel through the pool. However, there may be a number of balloons arranged in geometric shapes that keep them together in a stable formation within the pool. Their collective energies are amplified and the waves in the pool become much larger. Although a simple analogy, this may paint a picture of how particles are formed.

Fig 3.1 is an example of wave centers reflecting longitudinal in-waves that are traveling throughout the universe (i.e. traveling waves), similar to the example of the balloon in the pool. When in-waves are reflected, they become out-waves. This produces spherical, standing waves to a defined radius from the wave center (noted in blue color in Fig 3.1). The energy is contained within this radius and may be thought of as stored, or potential, energy. It is measured as the mass of the particle.

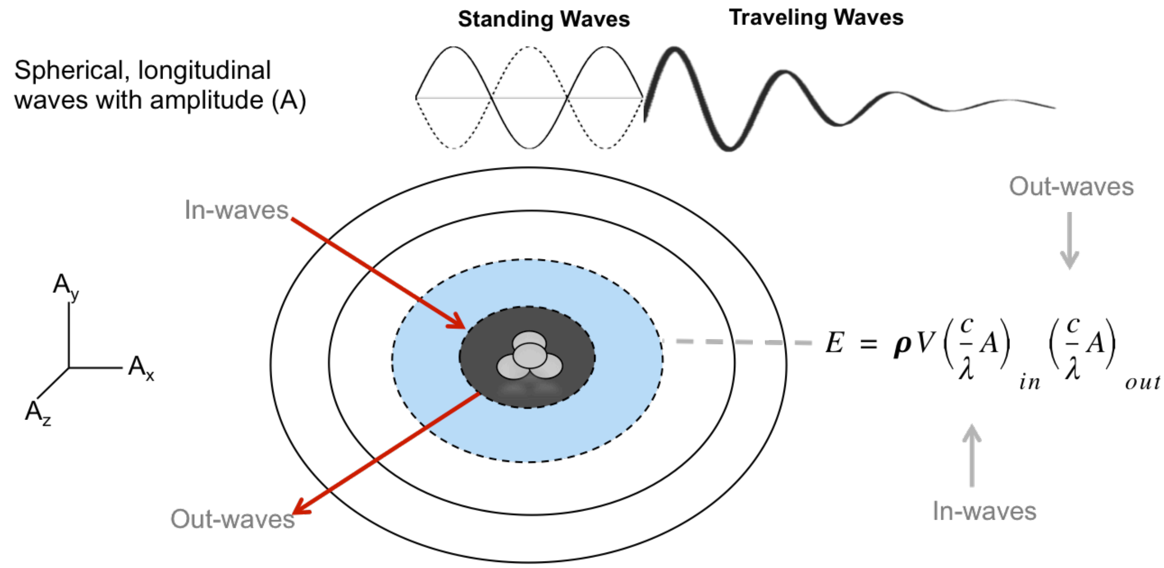



Fig 3.1 – Longitudinal Waves

The base wave energy equation is reflected by the fact that there is a frequency and amplitude for both the in-waves and out-waves, within a defined spherical volume that contains a medium (density property). This becomes the root of the longitudinal energy equation (Eq. 3.3) that will be further derived in Section 3.1.

$$E = \boldsymbol{\rho} V \left(\frac{c}{\lambda} A\right)_{in} \left(\frac{c}{\lambda} A\right)_{out} \tag{3.3}$$

In the balloon example, it is moving up-and-down in the pool, creating a secondary wave. A particle that is vibrating will create a similar wave that is transverse. It is still generating a longitudinal wave, but now has a secondary, transverse wave with a poynting vector in the direction of propagation. It is traveling and no longer stored energy in the particle – it is kinetic energy.

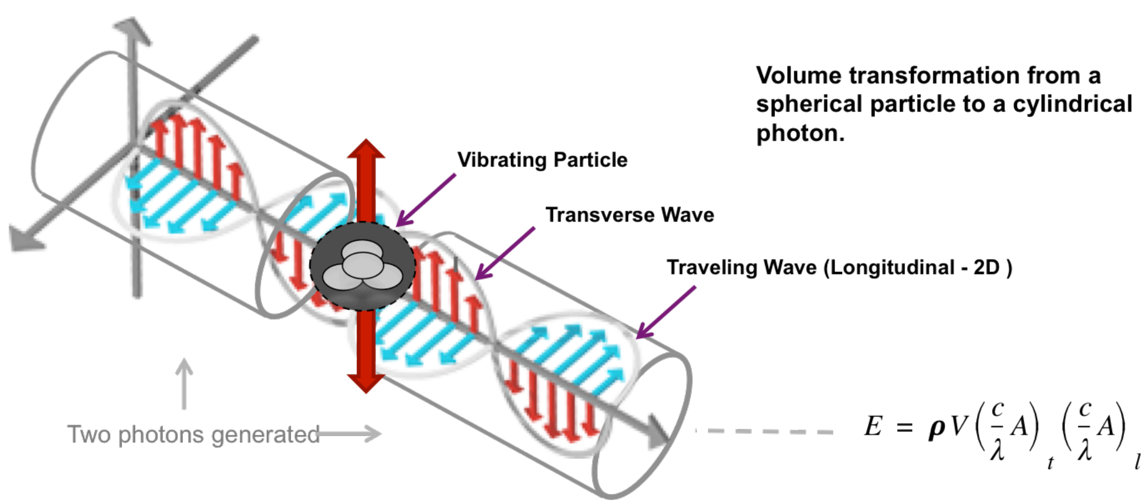



Fig 3.2 – Transverse Waves

The energy of this wave is very different than Eq 3.3. It no longer has an in-wave. It is a traveling, longitudinal (l) wave with a transverse component (t). It is no longer spherical, but collapses to a volume that is cylindrical. This is the base of the transverse equation that will be further derived in Section 3.2.

$$E = \boldsymbol{\rho} V \left(\frac{c}{\lambda} A\right)_t \left(\frac{c}{\lambda} A\right)_l \tag{3.4}$$

## 3.1. Longitudinal Energy Equation

The Longitudinal Energy Equation was shown in Section 1 to calculate a particle's rest energy. In this section, the equation is derived from the base energy wave equation. First, the following assumptions were required in the derivation, expanding on the wave theory laws also found in Section 1.

**Particle Formation Assumptions**

- The wave center is the fundamental particle, which is possibly the neutrino. Longitudinal in-waves are reflected to become out-waves. The amplitude of these waves decrease with the square of distance, with each wavelength, or shell (n).
- Lepton particles are created from a combination of wave centers. A number of wave centers (K) form the core of the particle, resulting in a standing wave formation from the combination of in-waves and out-waves.
- Wave centers prefer to reside at the node of the wave, minimizing amplitude. They will move to minimize amplitude if not at the node.
- With sufficient energy, wave centers may be pushed together in arrangement to create a new particle (i.e. neutrino oscillation), but will decay (break apart) if the structure does not lend itself to a geometric shape where each wave center resides at the node in a wave.
- When wave centers are spaced in the nodes, at even wavelengths in the core, waves are constructive. A particle's amplitude is the sum of its individual wave center amplitudes in the particle core.
- If two wave centers are pi-shifted from each other on the wave (1/2 wavelength) it will result in destructive waves. This is an anti-particle. For example, if the neutrino is the fundamental wave center, then the anti-neutrino is a wave center pi-shifted from the neutrino.
- Particle radius is proportional to the total wave amplitude, and is the edge of where standing waves convert to traveling, longitudinal waves.
- Mass is the energy of standing waves within the particle's radius.

A visual of the wave, its amplitude, wavelength and nodes is shown in Fig 3.1.1 – neutrinos are assumed in the figure to be the fundamental wave center. Neutrinos and anti-neutrinos reside in the node of the wave to minimize amplitude and will move towards the node. Neutrinos at wavelengths create constructive waves; a neutrino and anti-neutrino will be destructive due to wave phase difference.

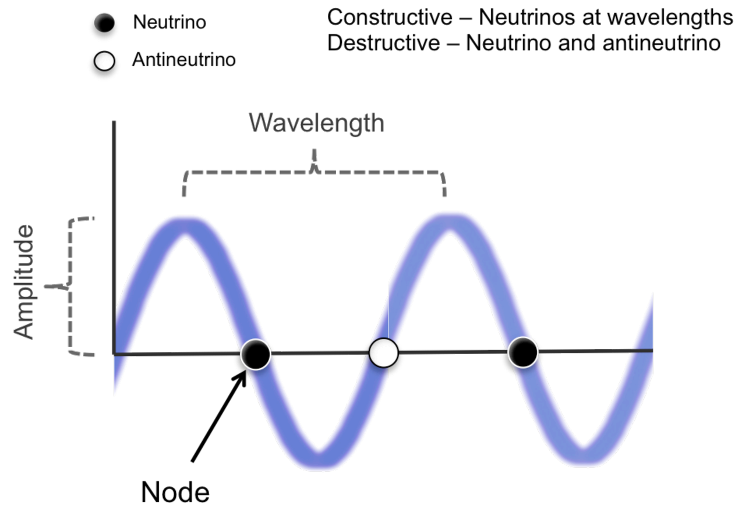



**Fig 3.1.1 – Nodes and Neutrino Placement**

Figure 3.1.2 illustrates a particle, such as an electron, that is formed from standing waves (in-waves and out-waves). Eventually, standing waves transition to traveling waves, as they cannot keep this form for infinity. This defines the particle radius, at the edge of where the transition occurs. The mass of the particle is then the energy captured within this radius, i.e. standing waves as shown below.

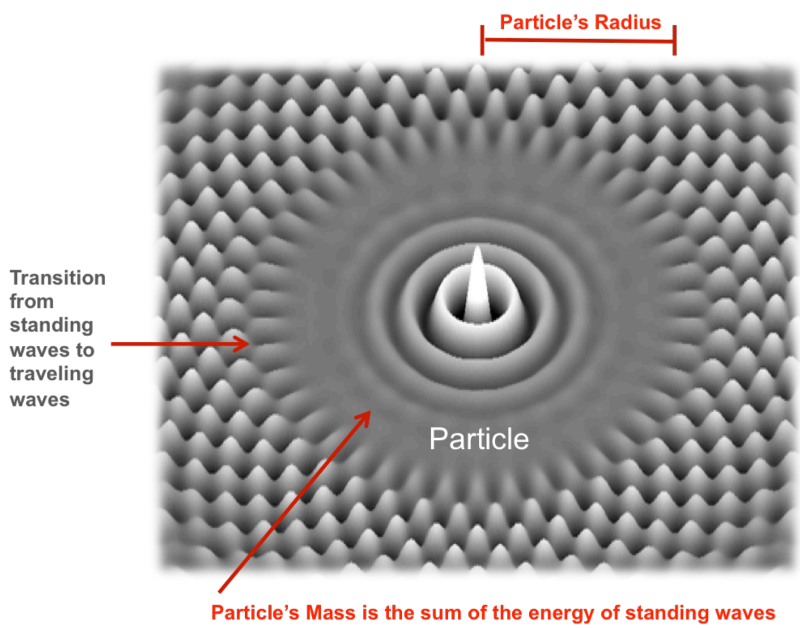



**Fig 3.1.2 – Particle Radius and Mass**

Fig. 3.1.3 describes spherical, longitudinal waves that have amplitude that decrease with the square of distance. As described in the assumptions in this section, the particle is assumed to consist of standing waves as a result of in-waves and out-waves. Also assumed is that the core of the particle may be made of one or more wave centers (K). Various combinations of wave centers (K) lead to different particles.

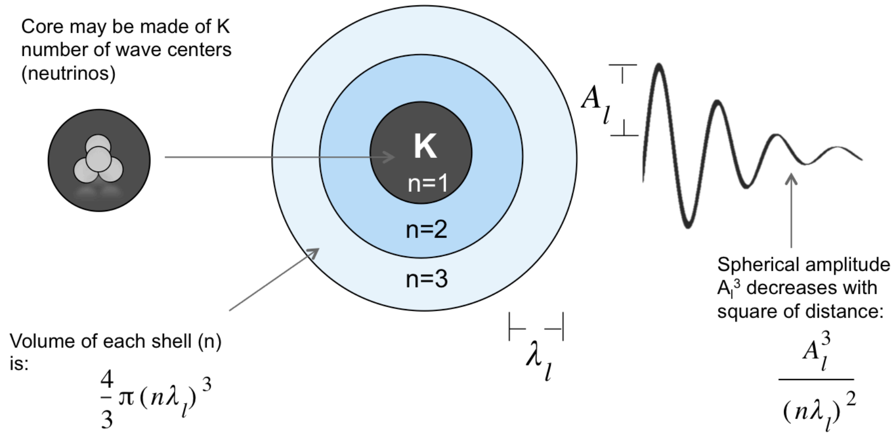



**Fig 3.1.3 –Spherical Longitudinal Waves Originating from Particle**

From Eq. 3.3, spherical amplitude is noted by $A_x$, $A_y$ and $A_z$ (or simply $A_l^3$ since they are equal) that decreases with the square of distance (r). This forms Eq. 3.1.1. At rest, the in-wave frequency and amplitude are the same so it can be simplified to Eq. 3.1.2, which also includes a spherical volume to replace V.

The number of wave centers in the particle affects the core distance ($r_{core}$). It is a measurement of wavelengths proportional to the number of wave centers (K) as shown in Eq. 3.1.3.

$$E_l = \boldsymbol{\rho} V \left(\frac{c}{\lambda_l}\right)_{in} \left(\frac{A_l^3}{r^2}\right)_{in} \left(\frac{c}{\lambda_l}\right)_{out} \left(\frac{A_l^3}{r^2}\right)_{out} \qquad \textbf{(3.1.1)}$$

$$E_l = \boldsymbol{\rho} \left(\frac{4}{3}\pi r^3\right) \frac{c^2}{\lambda_l^2} \left(\frac{A_l^3}{r^2}\right)^2 \qquad \textbf{(3.1.2)}$$

$$r_{core} = K\lambda_l \qquad \textbf{(3.1.3)}$$

Amplitude is also affected by the wave center count (K), similar to the particle's core. The resultant wave is the sum of the amplitudes. One assumption is that wave centers reside at wavelengths such that their amplitudes constructively combine, resulting in increased amplitude as described in Fig 3.1.4. Not every geometric relationship makes this possible for all particles, which leads to decay as wave centers are forced out of a stable position on a wave node. Certain geometric structures, particularly at magic numbers also seen in atomic elements, tend to be more stable than other particles when wave centers combine.

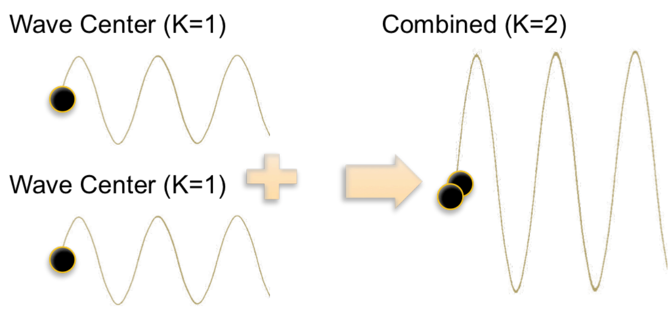



**Fig 3.1.4 –Constructive Waves**

The core of the particle contains a large amount of energy, based on constructive wave interference that adds amplitude based on the number of wave centers (K). Both amplitude (A) and the particle core radius (now replaced by Kλ in Eq. 3.1.4) are affected by K. The core energy at n=1 is:

$$E_{core} = \boldsymbol{\rho}\left(\frac{4}{3}\pi(K\lambda_l)^3\right)\frac{c^2}{\lambda_l^2}\left(\frac{(KA_l)^3}{(K\lambda_l)^2}\right)^2 \qquad \textbf{(3.1.4)}$$

The core contains the greatest amount of energy per wavelength as amplitude declines with the square of the distance from the center of the particle. However, the total energy or mass of the particle is contained within its standing waves as illustrated in Fig 3.1.2. Beyond the core, particles lose energy with each wavelength. The energy for each shell can be determined, based on the energy at the particle core, and further reduced as amplitude decreases. A particle's rest energy is the energy in each of these shells until standing waves transition to traveling waves.

Each particle's standing wave transition and thus particle radius (r) depends on the number of wave centers (K). It is made of (n) shell numbers of standing waves, each with a particle wavelength of Kλ. This is represented by Eq. 3.1.5. The transition to traveling waves occurs when the shell number matches the wave center count. In other words, n=K. The radius of a particle (r) is therefore $K^2\lambda$ as captured in Eq. 3.1.6.

$$r = nK\lambda_l \qquad \textbf{(3.1.5)}$$

$$r = K^2\lambda_l \qquad \textbf{(3.1.6)}$$

The entire stored energy of a particle becomes the sum of each of these shells (n) until it reaches the radius at n=K. Eq. 3.1.7 is the sum of each of these shells and becomes the energy equation - the sum of each shell (n) until K wave centers using the radius in Eq. 3.1.5. This value of r is substituted into the Eq. 3.1.2. However, when doing a summation of volume, it is for spherical shells, not the entire sphere, so it should be noted that volume is adjusted accordingly (n – (n-1)) for radius. This becomes the longitudinal energy equation to calculate stored energy from standing waves of a particle in Eq. 3.1.7.

Lastly, Eq. 3.1.7 can be simplified in Eq. 3.1.8 to become the Longitudinal Energy Equation.

$$E_{l(K)} = \sum_{n=1}^{K} \boldsymbol{\rho} \left(\frac{4}{3}\pi (n(K\lambda_l))^3 - \left(\frac{4}{3}\pi ((n-1)K\lambda_l)^3\right)\right) \frac{c^2}{\lambda_l^2} \left(\frac{(KA_l)^3}{(n(K\lambda_l))^2}\right)^2 \tag{3.1.7}$$

$$E_{l(K)} = \frac{4\pi\boldsymbol{\rho} K^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \tag{3.1.8}$$

**Longitudinal Energy Equation**

***Note:*** Standing waves complete at radius $K^2\lambda_l$, but longitudinal energy continues on beyond it as traveling waves.

## 3.2. Transverse Wavelength Equation

This section derives and explains the Transverse Wavelength Equation. It is derived prior to the energy equation in Section 3.3, as it will be required in the next section for the derivation of the Transverse Energy Equation. In Tables 1.3 through 1.6, photon wavelengths and energies were calculated using these two equations. Similar to the Longitudinal Energy Equation, the derivations started with assumptions for the transverse wave.

**Transverse Wave Assumptions**

The following assumptions were made when understanding particle interaction, including atomic orbitals:

- Particle vibration creates a transverse wave. A particle may vibrate upon annihilation, when transitioning between orbitals in an atom, or when an entire atom vibrates due to kinetic energy.
- Longitudinal amplitude difference creates particle motion as particles seek to minimize amplitude.
- The difference in longitudinal energy is transferred to transverse energy in a wave packet known as the photon.
- Particles and their anti-matter counterparts attract because of destructive waves between the particles; like particles (e.g. electron-electron) repel due to constructive waves, seeking to minimize amplitude.

- Electrons in an atomic orbital are both attracted and repelled by the nucleus. A positron is assumed to be at its core to attract the orbital electron; opposing forces in the nucleus repel the orbital electron. A potential model of the proton with this structure is explained in *Fundamental Physical Constants*.

A transverse wave is created from a vibrating particle, perpendicular to the direction of motion as illustrated in Fig. 3.2.1. A faster vibrating particle results in a transverse wave with a shorter wavelength than a particle that vibrates slower. The greater the longitudinal amplitude differences in a particle's interaction with surrounding particles, the faster the particle's vibration.

The outgoing, spherical longitudinal wave (out-wave) has an amplitude of $(K A_l)^3 / (K \lambda_l)^2$. In motion, the particle's vibration creates a secondary, transverse wave that takes on new characteristics as it transforms, including a new transverse amplitude and wavelength.

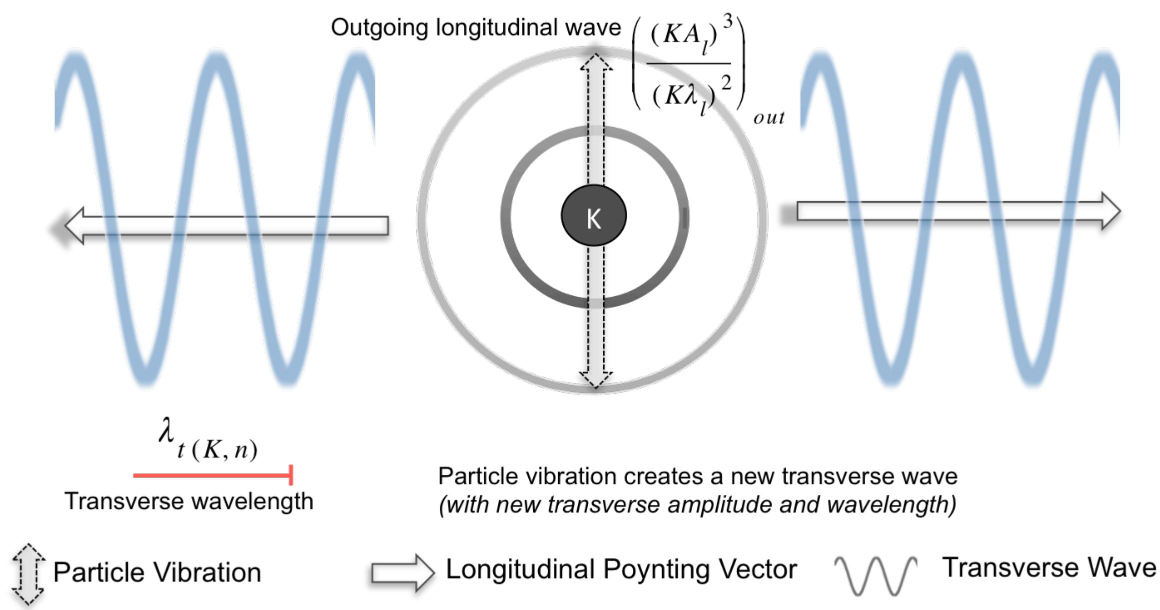
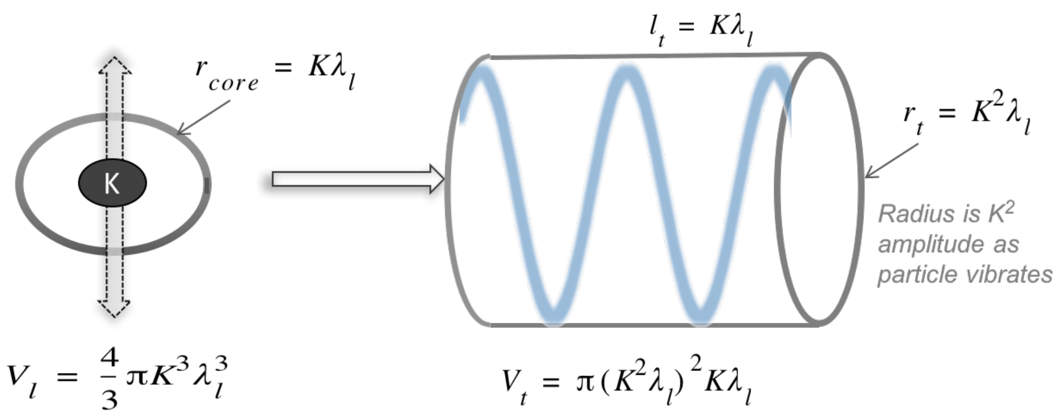



**Fig 3.2.1 –Transverse Wave Created by Particle**

During vibration, shell energy is transferred to a transverse wave in a volume (shape) that resembles a cylinder. The characteristic of this transition has an impact on the volume in which energy is stored. Figure 3.2.2 shows this volume transition from a spherical particle ($V_l$) to a cylindrical photon ($V_t$). The core, with a radius of ($K\lambda$), can vibrate to the particle's radius, which is the edge of the standing waves at $K^2\lambda$.




**Volume transformation from a spherical particle to a cylindrical photon.**

**Fig 3.2.2 –Volume Change – Longitudinal to Transverse**

The ratio of these two volumes ($V_{lt}$) is derived in the following:

$$V_{lt} = \frac{V_l}{V_t} \quad \textbf{(3.2.1)}$$

$$V_{lt} = \frac{\frac{4}{3}\pi K^3 \lambda_l^3}{\pi K^5 \lambda_l^3} \quad \textbf{(3.2.2)}$$

$$V_{lt} = \frac{4}{3K^2} \quad \textbf{(3.2.3)}$$

As the wave transitions from spherical to the cylindrical shape of the photon, the new, transverse wavelength is related to the original longitudinal amplitude ($A_l$) and volume transformation ($V_{lt}$) for a single shell as described in Eq. 3.2.4.

$$\lambda_t = A_l V_{lt} \quad \textbf{(3.2.4)}$$

The wavelengths and energies will be calculated over a difference between shells (n) with a starting position ($n_i$) and ending position ($n_f$) so the wavelength calculation is described as a function of wave centers (K) and shells (n) in Eq. 3.2.5. An illustration is provided to understand the initial and final starting positions of the electron in an orbital in

Fig. 3.3.3. It starts at initial position $n_i$ wavelengths from the nucleus core and ends at position $n_f$. Also pictured in the figure is a difference in amplitude as a result of constructive or destructive wave interference, amplitude factor δ.

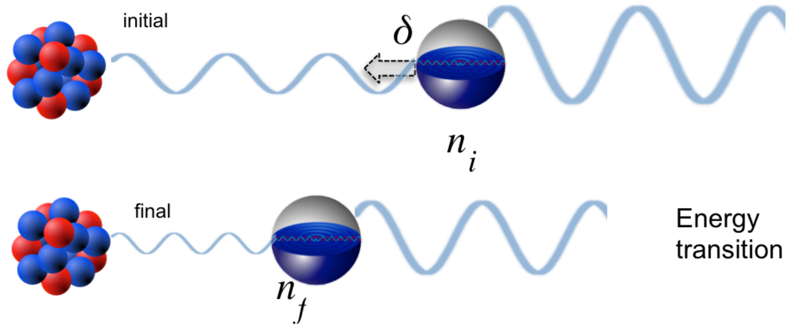



**Fig 3.3.3 – Energy Transition**

$$\lambda_{t\,(K,\,n_f - n_i)} = A_l V_{lt} \frac{1}{\left(\frac{1}{n_f} - \frac{1}{n_i}\right)} \tag{3.2.5}$$

$V_{lt}$ is known and can be added to the equation and then simplified. This is the transverse wavelength associated with a shell (n).

$$\lambda_{t\,(K,\,n_f - n_i)} = A_l \left(\frac{4}{3K^2}\right) \frac{1}{\left(\frac{1}{n_f} - \frac{1}{n_i}\right)} \tag{3.2.6}$$

$$\lambda_{t\,(K,\,n_f - n_i)} = \frac{4A_l}{3K^2} \frac{1}{\left(\frac{1}{n_f} - \frac{1}{n_i}\right)} \tag{3.2.7}$$

**Transverse Wavelength Equation (*without modifier*)**

Although it was not expected in the equation, a modifier ($\Delta_e$) is needed for the Transverse Wavelength Equation that is equal to the amplitude factor for the single electron ($\delta_e$). The value for the modifier is nearly 1.0, which was the expected result. Instead, its value is 0.99363. Refer to Fig 3.2.2 where it was assumed that particle volume is perfectly spherical and photon volume is perfectly cylindrical. This may not be the and could be the cause of the modifier.

After adding the modifier, it becomes the equation for computing transverse wavelengths in the energy wave equations.

$$\lambda_{t(K,n_f-n_i)} = \frac{4A_l}{3K^2}\frac{1}{\left(\frac{1}{n_f}-\frac{1}{n_i}\right)}(\Delta_e) \qquad \textbf{(3.2.8)}$$

Transverse Wavelength Equation

## 3.3. Transverse Energy Equation

In Fig. 3.2, a particle was shown to create two photons with a transverse wave along with its longitudinal, traveling wave. This illustration is now updated to show the base wave energy equation expanded to have these wave components. The energy equation for this wave will have both a transverse frequency and longitudinal frequency, described in Eq. 3.3.1, where $V_t$ is the volume of the cylindrical photon. It can also be thought of as the electrical and magnetic components of the electromagnetic wave.

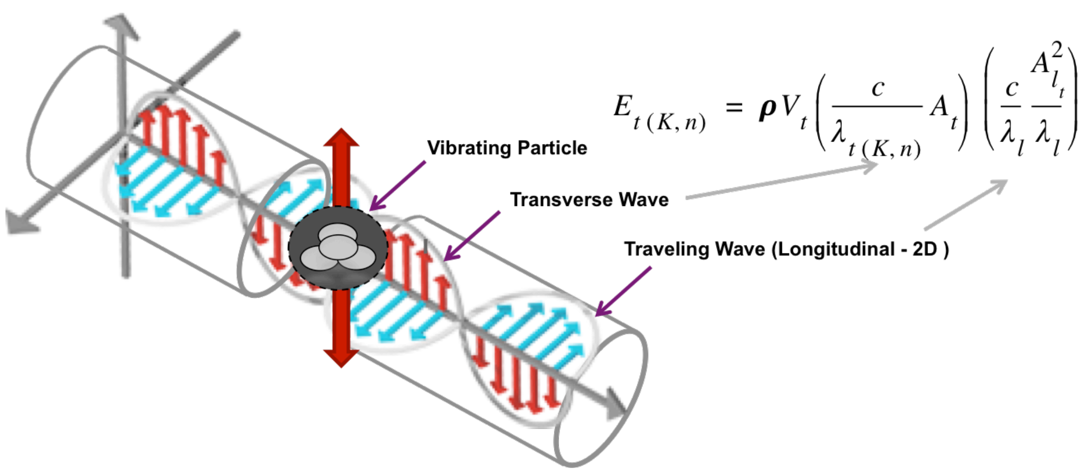



Fig 3.3.1 – Transverse Waves

The origin of this equation is again the base energy wave equation (Eq. 3.1), substituting the aforementioned volume, frequencies and amplitudes. Note that the traveling wave is no longer spherical and the longitudinal amplitude is modified with the volume change. It is $A_{lt}^2$ and its amplitude is reduced proportional to each wavelength. Its value is not known, nor is the amplitude for the transverse wave ($A_t$), however transverse wavelength was derived in Section 3.2. The energy equation takes the form:

$$E_{t\,(K,n)} = \boldsymbol{\rho} V_t \left( \frac{c}{\lambda_{t\,(K,n)}} A_t \right) \left( \frac{c}{\lambda_l} \frac{A_{l_t}^2}{\lambda_l} \right) \quad \textbf{(3.3.1)}$$

Although the amplitudes are not known, transverse amplitude is related to the inverse of the transformed longitudinal amplitude, which goes through a volume change from spherical to cylindrical (photon) as described in the volume ratio ($V_{lt}$). It is also affected by the amplitude factor (δ), which is the measure of constructive and destructive wave interference. This is described in Eq. 3.3.2.

$$A_t = \frac{2 V_{lt} \delta}{A_{l_t}^2} \quad \textbf{(3.3.2)}$$

$$A_t A_{l_t}^2 = 2 V_{lt} \delta \quad \textbf{(3.3.3)}$$

The relation of these amplitudes in Eq. 3.3.3 can be substituted into Eq. 3.3.1 as shown below. Next, $V_t$ and $V_{lt}$ from previous equations are used to expand the equation into Eq. 3.3.5 and simplified in Eq. 3.3.6.

$$E_{t\,(K,n)} = \boldsymbol{\rho} V_t \frac{c^2 2 V_{lt} \delta}{\lambda_{t\,(K,n)} \lambda_l^2} \quad \textbf{(3.3.4)}$$

$$E_{t\,(K,n)} = \boldsymbol{\rho} \pi (K^2 \lambda_l)^2 K \lambda_l \frac{c^2 2 \delta}{\lambda_{t\,(K,n)} \lambda_l^2} \frac{4}{3K^2} \quad \textbf{(3.3.5)}$$

$$E_{t\,(K,n)} = \frac{8}{3} \pi \boldsymbol{\rho} K^3 \lambda_l c^2 \delta \frac{1}{\lambda_{t\,(K,n)}} \quad \textbf{(3.3.6)}$$

At this point, Planck's constant (h) is apparent in the equation. The Planck relation (E=hf) is further described in Section 5.4.

The energy of one particle shell (n) can be calculated, knowing the transverse wavelength from Section 3.2. Using the Transverse Wavelength Equation (without the modifier), one subshell simplifies to Eq. 3.3.7. This value replaces the transverse wavelength in Eq. 3.3.6.

$$\lambda_{t\,(K,n)} = \frac{4nA_l}{3K^2} \tag{3.3.7}$$

$$E_{t\,(K,n)} = \frac{8}{3}\pi\rho K^3 \lambda_l c^2 \delta \frac{1}{\frac{4nA_l}{3K^2}} \tag{3.3.8}$$

The above is now simplified to become the transverse energy equation for a given particle shell (n).

$$E_{t\,(K,n)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{nA_l} \tag{3.3.9}$$

Photon energies are calculated using the difference in energy as particles annihilate or electrons change orbits, so the above equation is represented as a change in energy difference in the following equations. Similar to the Transverse Wavelength Equation, $n_i$ is the initial position of the particle in subshells (n) relative to a particle it is interacting with, and $n_f$ is the final position.

$$E_{t\,(K,n_f - n_i)} = \Delta E \tag{3.3.10}$$

$$E_{t\,(K,n_f - n_i)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{n_f A_l} - \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{n_i A_l} \tag{3.3.11}$$

The above is simplified to become the Transverse Energy Equation.

$$E_{t\,(K,\,n_f - n_i)} = \frac{2\pi\rho K^5 \lambda_l c^2 \delta}{A_l}\left(\frac{1}{n_f} - \frac{1}{n_i}\right) \qquad \textbf{(3.3.12)}$$

**Transverse Energy Equation**

The Transverse Energy Equation can also be represented in radius (meters) instead of wavelengths. Since radius is related to the number of wavelengths as:

$$r = nK_e^2\lambda_l \qquad \textbf{(3.3.14)}$$

$$n = \frac{r}{K_e^2\lambda_l} \qquad \textbf{(3.3.15)}$$

Substituting Eq. 3.3.15 into Eq. 3.3.12 to get the Transverse Energy Equation in meters:

$$E_{t\,(K,\,r_f - r_i)} = \frac{2\pi\rho K^7 \lambda_l^2 c^2 \delta}{A_l}\left(\frac{1}{r_f} - \frac{1}{r_i}\right) \qquad \textbf{(3.3.16)}$$

**Transverse Energy Equation – Meters (radius from particle core)**

## Relation of Transverse Energy to Longitudinal Energy

This section validates both energy equations (transverse and longitudinal) by comparing energy values of known experiments and also by relating the two mathematically.

As it was shown in the annihilation section (Section 2.7), when a positron and electron annihilate they emit two gamma rays equal to the combined energy of the positron and the electron. Energy is always conserved. Two transverse waves, or photons ($E_t$) are created for each change in longitudinal energy ($E_l$). Mathematically, this is represented as:

$$E_l = 2E_t \qquad \textbf{(3.3.17)}$$

The modifier ($\Delta_e$ – value of 0.9936) was introduced earlier to account for imperfections in the wave constants in changes between transverse and longitudinal energy. Accounting for it, Eq. 3.3.17 looks like this:

$$E_l = 2E_t(\varDelta_e^{-1}) \qquad \textbf{(3.3.18)}$$

First, checking the values of each equation for the complete annihilation of one particle – the electron. If the mass of the electron were converted to transverse energy, the longitudinal energy is equal to the mass of the electron (Eq. 3.3.19) and two photons would also equal the mass of the electron (Eq. 3.3.20). $E_l$ is replaced with the Longitudinal Energy Equation and $E_t$ is replaced with the Transverse Energy Equation. Note that n=1 in Eq. 3.3.20. Both sides of Eq. 3.3.18 result in the mass of the electron (8.1871 x $10^{-14}$ joules).

$$E_l = \frac{4\pi\rho K_e^5 A_l^6 c^2}{3\lambda_l^3} O_e = 8.1871E-14 \qquad \textbf{(3.3.19)}$$

$$E_t = (2)\frac{2\pi\rho K_e^5 \lambda_l c^2 \delta_e}{(1)A_l}(\varDelta_e^{-1}) = 8.1871E-14 \qquad \textbf{(3.3.20)}$$

Mathematically, they can be proven to be equal after introducing another form of $O_e$. Earlier it was introduced as shown in Eq. 3.3.21 and the value of $O_e$ is equal to 2.13874 for the electron at K=10. Eq. 3.3.22 is a different form of this electron constant, but note the values are the same.

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} = 2.13874 \qquad \textbf{(3.3.21)}$$

$$O_e = \frac{3\lambda_l^4 \delta_e}{A_l^7}(\varDelta_e^{-1}) = 2.13874 \qquad \textbf{(3.3.22)}$$

Taking the energy equation in Eq. 3.3.18 and then inserting longitudinal and transverse energies from Eq. 3.3.19 and Eq. 3.3.20 gives Eq. 3.3.23 below. This represents two photons created for the electron. Then, substitute $O_e$ from Eq. 3.3.22 into Eq. 3.3.23. This becomes eq. 3.3.24. After simplifying both sides of the equation, note that they are identical, as shown in Eq. 3.3.25.

$$\frac{4\pi\rho K_e^5 A_l^6 c^2}{3\lambda_l^3} O_e = (2)\frac{2\pi\rho K_e^5 \lambda_l c^2 \delta_e}{(1)A_l}(\varDelta_e^{-1}) \qquad \textbf{(3.3.23)}$$

$$\frac{4\pi\rho K_e^5 A_l^6 c^2}{3\lambda_l^3}\left(\frac{3\lambda_l^4 \delta_e}{A_l^7}(\Delta_e^{-1})\right) = (2)\frac{2\pi\rho K_e^5 \lambda_l c^2 \delta_e}{(1)A_l}(\Delta_e^{-1}) \qquad \textbf{(3.3.24)}$$

$$\frac{4\pi\rho K_e^5 \lambda_l c^2 \delta_e}{A_l}(\Delta_e^{-1}) = \frac{4\pi\rho K_e^5 \lambda_l c^2 \delta_e}{A_l}(\Delta_e^{-1}) \qquad \textbf{(3.3.25)}$$

These steps are the mathematical proof that two photons are created as transverse waves for the longitudinal energy that is converted into photons. The steps can be used for the transfer at any radius from the electron, which will be detailed in a forthcoming paper.

## 3.4. Orbital Equation

While modeling transverse energies for hydrogen it was noticed that the first orbital and the fine structure constant had a relationship, which is the Bohr radius. The calculation of the Bohr radius was explained in Section 2.2. After determining the relationship, a pattern was noticed for the remaining orbitals that matched existing data. Thus the orbital equation was not derived specifically from assumptions, but from patterns in the data. The Orbital Equation is shown again in Eq. 3.4.1.

$$n_N = \left(\frac{N}{\alpha_e}\right)^2 \qquad \textbf{(3.4.1)}$$

**Orbital Equation**

An attempt to explain the Orbital Equation is illustrated in Fig. 3.4.1. The nucleus of an atom contains both constructive and destructive wave interference. It is assumed that there is a force that pushes outward on an electron in the orbital, but it is attracted by the positive charge that creates destructive waves. In essence, the electron is being pushed and pulled. Orbitals are based on the geometric arrangement of protons and neutrons in a nucleus that cause wave interference. At the point of wave cancellation, the electron finds minimal amplitude and has a resting position.

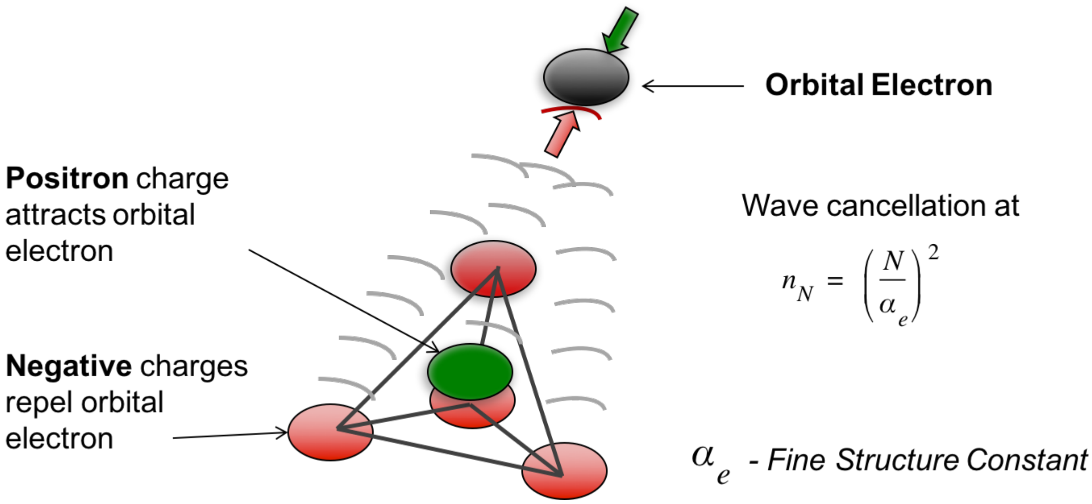



**Fig 3.4.1 – Orbitals at Wave Cancellation Points**

This paper does not propose a proton structure, but further work on the structure is found in *Fundamental Physical Constants* and *Forces*. In particular, the *Forces* paper shows an interesting similarity between the electromagnetic force, holding the electron in orbit, and the strong force. The strong force is related to the inverse of the fine structure constant, while the electromagnetic force is related to the inverse of the fine structure constant squared.

## 3.5. Amplitude Factor Equation

Eq. 3.5.1 is another equation that was created to match patterns in data, rather than derived. However, the beauty of the equation became apparent after factoring electrons from the second orbital (2s, 2p) as the pattern began to emerge. The pattern held true until element number 20 in the Periodic Table (calcium), which is when electrons begin filling out the 3d subshell after completing the 4s subshell. Thus the Amplitude Factor Equation only works for the first twenty elements and only calculates the ionization of electrons from the first orbital (1s).

$$\delta = \left(Z - \frac{4}{3}\left(\frac{(N1e-1)}{2} + \frac{N2e}{8} + \frac{1}{2}\left(\frac{N3e}{8}\right) + \frac{1}{3}\left(\frac{N4e}{8}\right)\right)\right)^2 \qquad \textbf{(3.5.1)}$$

**Amplitude Factor Equation – 1s Orbital Ionization**

In Fig. 3.5.1, note the order in which electrons fill the subshells in an atom. The first orbital (1s) has two electrons. The next orbitals have eight electrons each in the s and p subshells (e.g. 2s + 2p = 8 electrons). Note the denominator in the Amplitude Factor Equation. The equation stops working at calcium because electrons begin to fill subshell 3d before they fill subshell 4p.

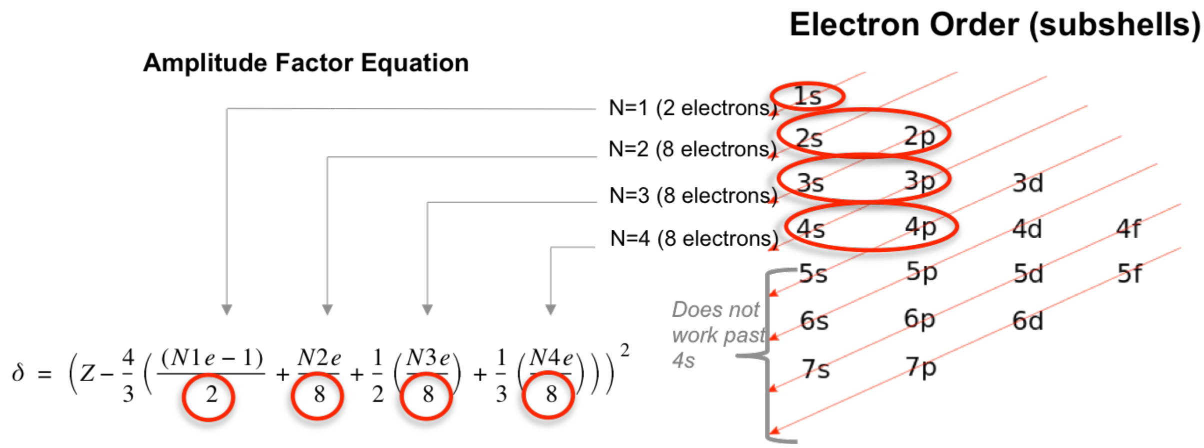



**Fig 3.5.1 – Orbitals at Wave Cancellation Points**

Electron orbitals are simply a difference in amplitude and can be modeled by various amplification factors. With additional modeling, it is expected that the remaining orbitals can be calculated for all elements.

## 3.6. 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.[16] Meanwhile, the electron family, like many other particles, are known to decay into particles of smaller mass. This implies that there may be 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 Table 1.1, 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. According to Table 1.1, 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.

Included in the Appendix are wave center calculations of composite particles such as pions and kaons, and also the W, Z and Higgs bosons to help explain potential decay methods.

## 3.7. 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.[17] 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.

In wave theory, light is a wave. It does not have mass as mass is defined as stored energy in standing waves. It is not a particle, as particles 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. 3.7.1 illustrates an electron's path and the vibrating motion that creates the wave.

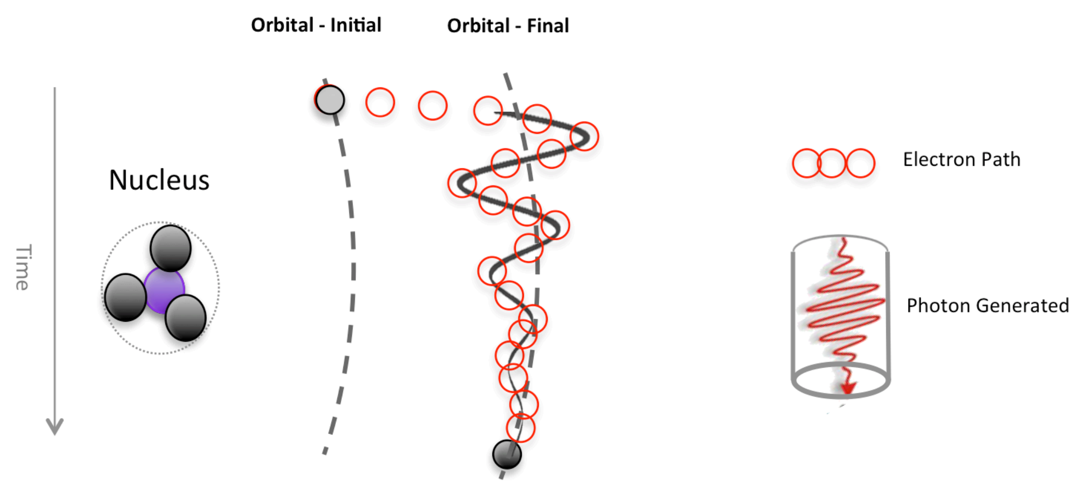



**Fig 3.7.1 – Electron Path – Creating a Transverse Wave**

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. 3.7.1.

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.

## 3.8. 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.[18] 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 3.7, it has been explained that light does travel in packets, or photons, and is not a continuous wave, although it carries transverse and longitudinal traveling wave components described earlier in this section. 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. 3.8.1. 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, traveling waves. This was modeled in the Longitudinal Energy Equation. 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. 3.8.1. Note the electron does not go through both slits. It is a particle and can only go through one slit.

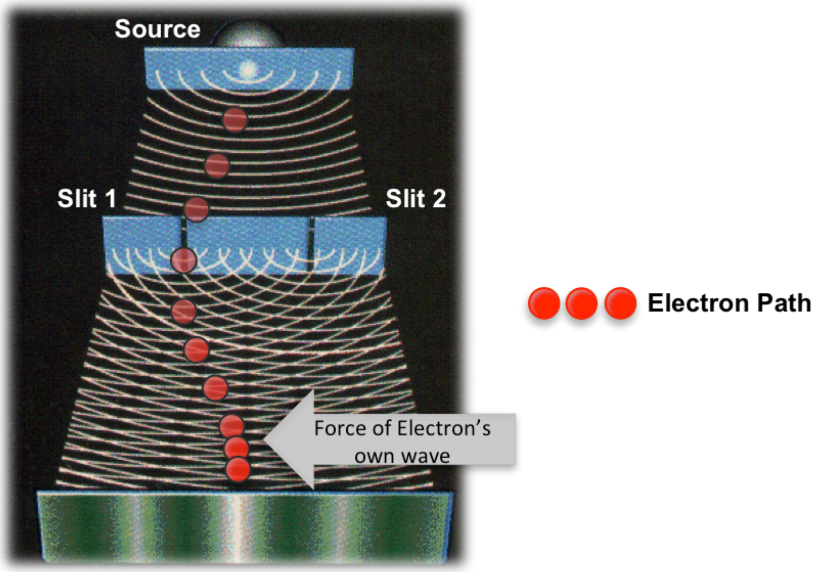



**Fig 3.8.1 – Double Slit Experiment**

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. It is not a particle defined in this theory as containing wave centers.

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.

# 4. Methodology for Determining Energy Wave Equation Constants

This section describes the methodology that was used to find the constants that are used in the energy wave equations: 1) Longitudinal Amplitude, 2) Longitudinal Wavelength and 3) Density. The fourth constant that is critical in these equations is already well known – the speed of light constant which is the speed at which waves travel through the aether.

## 4.1. Longitudinal Wavelength Constant

Longitudinal wavelength is based on the classical radius of the electron ($r_e$). When modeling the electron based on standing waves of energy, using the Longitudinal Energy Equation, it was assumed that amplitude and wavelength were proportional to the number of particle wave centers (K). Particles have a core at K times wavelengths and a radius at $K^2$ times wavelengths ($\lambda_l$). With the neutrino assumed as the fundamental particle, the electron fits the equation at K=10, or ten particle wave centers. Knowing the classical radius of the electron, and the value K for the electron, wavelength can be solved using the assumption of radius - $K^2 * \lambda_l$.

The following is the calculation of Longitudinal Wavelength ($\lambda_l$) in meters:

$$\lambda_l = \frac{r_e}{K_e^2} \tag{4.1.1}$$

$$\lambda_l = \frac{2.817940327 \cdot 10^{-15}}{10^2} \tag{4.1.2}$$

**Calculated Value:** 2.817940327E-17 (m)

*Note:* A wavelength of $2.81794 \times 10^{-17}$ meters puts the electron's core radius at $2.81794 \times 10^{-16}$ meters (n=10 wavelengths), or one-third the radius of a proton.[19]

## 4.2. Longitudinal Amplitude Constant

Knowing the longitudinal wavelength constant, the longitudinal amplitude was solved using the derivation of the fine structure constant, found in the *Fundamental Physical Constants* paper. The derivation for the fine structure constant is in Eq. 4.2.1 and its CODATA value in 4.2.2:

$$\alpha_e = \frac{\pi K_e^4 A_l^6 O_e}{\lambda_l^3 \delta_e} \tag{4.2.1}$$

$$\alpha_e = 0.007297352566417 \tag{4.2.2}$$

The value K for the electron ($K_e$) and longitudinal wavelength are known, but two other constants appear in the equation to be explained. $O_e$ is a constant provided for readability of the Longitudinal Energy Equation. It can be expanded as follows in Eq. 4.2.3 for the electron. Lastly the amplitude factor for the electron is derived earlier and is found in Eq. 4.2.4, but to avoid a circular reference, the value is used.

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \tag{4.2.3}$$

$$\delta_e = 0.99363 \tag{4.2.4}$$

As all of the constants are known in Eq. 4.2.1 with the exception of longitudinal amplitude, it is isolated from the equation and then solved.

$$A_l = \left(\frac{\alpha_e \lambda_l^3 \delta_e}{\pi K_e^4 O_e}\right)^{1/6} \tag{4.2.5}$$

**Calculated Value:** 3.662796647E-10 (m)

## 4.3. Aether Density Constant

Aether density was calculated using the well-known value for the Planck constant (6.62607004081E-34) that was derived in *Fundamental Physical Constants* (see Eq. 4.3.1) and provided again in the upcoming section 5.4 in this paper. Planck constant is related to constants already solved above, so density (**ρ**, in kg/m$^3$), can be isolated and solved in Eq. 4.3.2.

$$h = \frac{8}{3}\pi\boldsymbol{\rho} K_e^3 \lambda_l c \delta_e \qquad \textbf{(4.3.1)}$$

$$\boldsymbol{\rho} = \frac{3}{8\pi K^3 \lambda_l c \delta_e} \qquad \textbf{(4.3.2)}$$

**Calculated Value:** 9.422369691E-30 ($kg/m^3$)

*Note:* An aether density of $9.422 \times 10^{-30}$ kg / $m^3$ is slightly less dense than the critical density of the universe (although it is not certain that aether density is consistent across the universe).

# 5. Deriving Classical Equations from the Energy Wave Equation

Introducing a new energy wave equation that describes the energies of particles and their interactions must also fit known classical and quantum equations, as these equations have been rigorously tested and proven. In this section, the energy wave equation is used to derive these equations as the base from which they form. Further, by looking at these equations in a new way, based on waves of energy, they can also be explained. Section 5.1 attempts to explain the equations, with further details and derivations about each of the energy equations and relativity in Sections 5.2 to 5.5.

## 5.1. Energy Relationship

The fundamental energy equations are mass-energy ($E=mc^2$), energy-momentum ($E=pc$) and Planck relation ($E=hf$). Long ago, Einstein proposed the relationship for rest mass and momentum in a simple equation ($E^2=(mc^2)^2+(pc)^2$), but the tie to quantum energies and the Planck relation is not well understood. Furthermore, there remain mysteries like annihilation and pair production, where electrons and positrons appear from a vacuum, which is not tied to any of these equations. For the latter, it is well understood that energy is conserved, i.e. that annihilation produces photons equal to the energy of the particles, but the mechanism for how it works is not covered by classical equations.

The following sections will derive the classical equations, including relativity, but this section starts first with a simple explanation of why these energy equations work and how they are related, including the annihilation and creation of particles.

A single particle, in Fig 5.1.1, consists of spherical, longitudinal waves. In the figure, this has been simplified to a simple sine wave to illustrate frequency and amplitude difference. At rest, the particle resonates at the same frequency as its in-waves and has minimized its amplitude difference to maintain a stable position. At rest, there is no frequency or amplitude difference relative to the waves that travel the aether.

When a single particle is in motion, its frequency changes similar to waves experiencing the Doppler effect. Its leading edge will have a higher frequency than its trailing edge, shown in Fig 5.1.1. It experiences a change in frequency and wavelength relative to the in-waves of its surroundings.

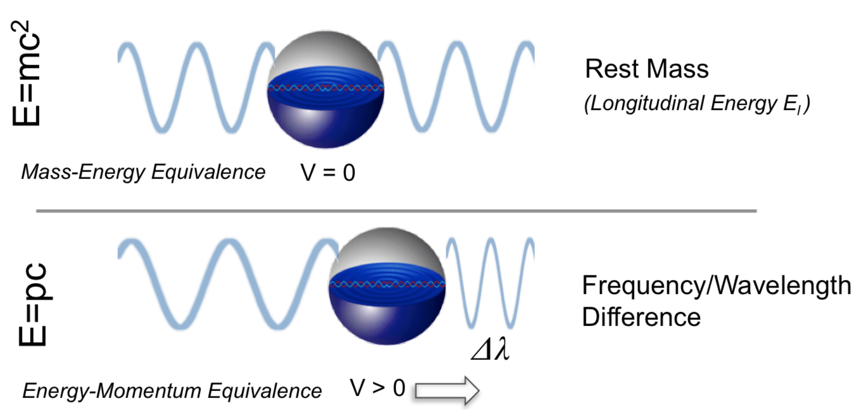



**Fig 5.1.1 –Energy Relationship – Single Particle**

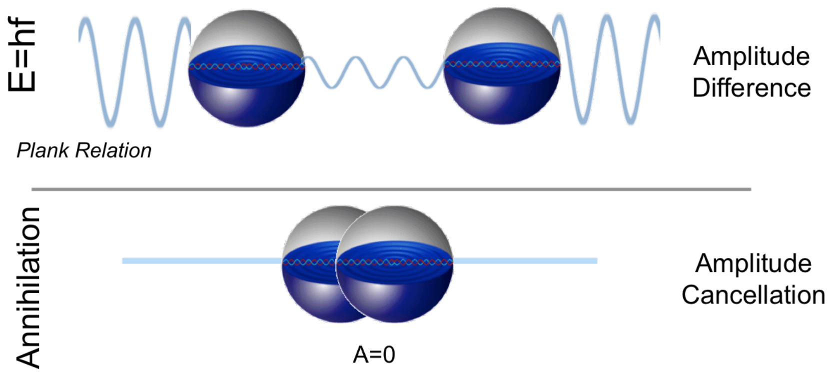



**Fig 5.1.2 –Energy Relationship –Particle Interaction**

In Figure 5.1.2, two particles interact and may create constructive or destructive wave interference that causes a difference in amplitude. In an electron and positron interaction, the phase difference of their waves are destructive between the particles causing attraction; two like particles (e.g. electron and electron) are constructive causing the particles to repel. When particles like the electron and positron are attracted, they will move to the point of amplitude minimization unless otherwise repelled by additional particle(s).

Annihilation is the point where two particles converge such that there is complete amplitude cancellation. The particles have minimized their amplitude. However, if an electron is attracted by a positron in an atom, it maintains an orbit due to a gap in wave cancellation from opposing forces, as described in Section 3.4. In this case, there is an amplitude difference and the change in its position and longitudinal amplitude creates a transverse wave with a frequency proportional to amplitude difference. This becomes the Planck relation described in further detail in Section 5.4.

To summarize, the energy equations are simply a difference in amplitude or frequency relative to the universal waves that travel the aether.

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

As described in Section 3.1, mass is the sum of standing waves within the particle's boundaries before standing waves convert to traveling waves. Mass is apparent in the Longitudinal Energy Equation, as it is energy divided by the square of the wave speed ($c^2$).

From the Longitudinal Energy Equation

$$E_{l(K)} = \frac{4\pi\rho K^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(5.2.1)}$$

Mass is the equation without c²

$$m_{(K)} = \frac{4\pi\boldsymbol{\rho} K^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(5.2.2)}$$

Subtitute mass back into equation for **E=mc²**

$$E_{l(K)} = m_{(K)} c^2 \quad \textbf{(5.2.3)}$$

Proof of this equation was demonstrated in Table 1.1 by calculating the energy of the electron at K=10. Further proof of the equation is demonstrated by validating the mass of the electron, using Eq. 5.2.2 for mass, with the known rest mass of the electron (Eq. 5.2.5, in kilograms).

Solving for mass of the electron

$$m_e = m_{(10)} = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6}{3\lambda_l^3} \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(5.2.4)}$$

Mass of electron (units derive to kg)

$$m_e = 9.109 \cdot 10^{-31} \quad \textbf{(5.2.5)}$$

## 5.3. Energy-Momentum Equivalence (E=pc)

Particle motion results in a frequency change, which was illustrated in Fig. 5.1.1. 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 (labeled in the following equations as the X axis).

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, shown in Eq. 5.3.3. The Lorentz Factor then becomes apparent upon taking the mean of this frequency (Eq. 5.3.7), and will be used later to describe Relativity in Section 5.5.

The following derives the Energy-Momentum relation:

Energy at rest

$$E_0 = \boldsymbol{\rho} V (f_0 A)^2 \quad \textbf{(5.3.1)}$$

Energy equation when moving in

$$E = \boldsymbol{\rho} V f_0 \Delta f_x A^2 \quad \textbf{(5.3.2)}$$

direction X

$f_x$ is the geometric mean of lead and lag frequency

$$\Delta f_x = \sqrt{f_{lead} f_{lag}} \quad \textbf{(5.3.3)}$$

Doppler equation. Frequency of leading edge.

$$f_{lead} = \frac{f_0}{\left(1 - \frac{\Delta v}{c}\right)} \quad \textbf{(5.3.4)}$$

Doppler equation. Frequency of trailing (lag) edge.

$$f_{lag} = \frac{f_0}{\left(1 + \frac{\Delta v}{c}\right)} \quad \textbf{(5.3.5)}$$

Combine Eqs 5.3.3 – 5.3.5. $f_x$ as function of initial frequency.

$$\Delta f_x = \frac{f_0}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(5.3.6)}$$

Lorentz factor is seen in Eq. 5.3.6.

$$\gamma = \frac{1}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(5.3.7)}$$

Subtitute Eq. 5.3.6 back into Eq. 5.3.2.

$$E = \frac{\boldsymbol{\rho} V f_0 f_0 A^2}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(5.3.8)}$$

Substitute wavelength for frequency.

$$E = \frac{\boldsymbol{\rho} V A^2 c^2}{\lambda_0^2 \sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(5.3.9)}$$

Rest mass is energy divide $c^2$

$$m_0 = \frac{\rho V A^2}{\lambda_0^2} \quad \textbf{(5.3.10)}$$

Subtitute Eq. 5.3.10 into 5.3.9

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(5.3.11)}$$

Square both sides

$$E^2 = \frac{m_0^2 c^4}{1 - \frac{\Delta v^2}{c^2}} \quad \textbf{(5.3.12)}$$

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

$$m^2 c^4 = \frac{m_0^2 c^4}{1 - \frac{\Delta v^2}{c^2}} \quad \textbf{(5.3.13)}$$

$$m^2 c^4 \left(1 - \frac{\Delta v^2}{c^2}\right) = m_0^2 c^4 \quad \textbf{(5.3.14)}$$

$$m^2 c^4 - \frac{m^2 v^2 c^4}{c^2} = m_0^2 c^4 \quad \textbf{(5.3.15)}$$

Rearrange to isolate "mv"

$$m^2 c^4 - (mv)^2 c^2 = m_0^2 c^4 \quad \textbf{(5.3.16)}$$

Momentum (p) is mass times velocity

$$p = mv \quad \textbf{(5.3.17)}$$

Subtitute Eq. 5.3.17 into 5.3.16

$$m^2 c^4 - p^2 c^2 = m_0^2 c^4 \quad \textbf{(5.3.18)}$$

$$E^2 - p^2c^2 = m_0^2c^4 \quad \textbf{(5.3.19)}$$

**Einstein's energy-momentum equation**

$$E^2 = (m_0c^2)^2 + (pc)^2 \quad \textbf{(5.3.20)}$$

## 5.4. Planck Relation (E=hf)

Planck's relation is a result of a transverse wave, from the vibration of a particle due to a difference in amplitude, as described in Section 3.2. This may happen during annihilation of a particle, or when a particle transitions between orbitals in an atom. The derivation of this relation thus starts with the transverse energy equation, starting at Eq. 3.3.6 before transverse wavelength has been substituted. In this equation, shown again in Eq. 5.4.1, Planck's constant (h) is apparent. After showing the derivation of Planck's relation in Eq. 5.4.4, the constant (h) is then validated as a final step in Eq. 5.4.6.

Equation 3.3.6 with transverse wavelength

$$E_{t(K,n)} = \frac{8}{3}\pi\boldsymbol{\rho}K^3\lambda_l c^2\delta\frac{1}{\lambda_{t(K,n)}} \quad \textbf{(5.4.1)}$$

Planck's constant (w/out wavelength)

$$h_{(K)} = \frac{8}{3}\pi\boldsymbol{\rho}K^3\lambda_l c\delta \quad \textbf{(5.4.2)}$$

Subtitute Eq. 5.4.2 into 5.4.1

$$E_{t(K,n)} = h_{(K)}\frac{c}{\lambda_{t(K,n)}} \quad \textbf{(5.4.3)}$$

Replace wavelength with frequency. **E=hf.**

$$E_{t(K,n)} = h_{(K)}f_{t(K,n)} \quad \textbf{(5.4.4)}$$

Validation: Planck's constant when K=10 (electron)

$$h_{(10)} = \frac{8}{3}\pi\boldsymbol{\rho}K_e^3\lambda_l c\delta_e \quad \textbf{(5.4.5)}$$

Planck's Constant ($m^2$ kg /s)

$$h_{(10)} = 6.62589\cdot10^{-34} \quad \textbf{(5.4.6)}$$

## 5.5. 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 Mass and Energy**

In section 5.3, 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. 5.3.7 as the geometric mean of frequencies, relative to the initial frequency. In 5.5.5 and 5.5.6, this factor is apparent in the relativistic mass and energy derivations respectively.

From Eq. 5.3.8

$$E = \frac{\boldsymbol{\rho} V f_0 f_0 A^2}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \quad \textbf{(5.5.1)}$$

Subtitute Lorentz Factor Eq. 5.3.7 into Eq. 5.5.1

$$E = \gamma \cdot \boldsymbol{\rho} V f_0 f_0 A^2 \quad \textbf{(5.5.2)}$$

Change frequency for wavelength

$$E = \gamma \frac{\boldsymbol{\rho} V A^2 c^2}{\lambda_0^2} \quad \textbf{(5.5.3)}$$

Mass – same as Eq. 5.3.10

$$m_0 = \frac{\boldsymbol{\rho} V A^2}{\lambda_0^2} \quad \textbf{(5.5.4)}$$

Substitute Eq. 5.5.4 into 5.5.3 and divide $c^2$ for mass

$$m = \gamma m_0 \tag{5.5.5}$$

Subtitute 5.5.5 into $E=mc^2$ equation. **Relative energy.**

$$E = \gamma m_0 c^2 \tag{5.5.6}$$

**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 frequency change of a particle from Eq. 5.3.6, in which the Lorentz factor is introduced again. Assuming that our measurement of time is based on this frequency, then Eq. 5.5.9 matches the time dilation equation.[20]

From Eq. 5.3.6

$$\Delta f_x = \frac{f_0}{\sqrt{1 - \frac{\Delta v^2}{c^2}}} \tag{5.5.7}$$

Substitute Eq. 5.3.7 into 5.5.7.

$$\Delta f_x = \gamma f_0 \tag{5.5.8}$$

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

$$\Delta t_x = \gamma t_0 \tag{5.5.9}$$

**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 in Table 1.2 as 18,779 wavelengths from the particle core. When in motion, its electron will still be 18,779 wavelengths from the particle core, but with shorter wavelengths, it will be closer to the nucleus as illustrated in Fig 5.5.1.

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. 5.5.12 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. 5.5.8, and the following derivation concludes with a length contraction equation that matches Einstein's relativity. [21]

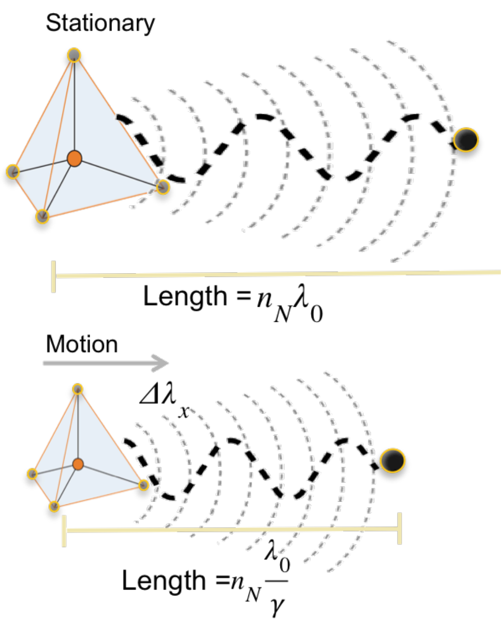



**Fig 5.5.1 –Length Contraction**

| | | |
|---|---|---|
| Replace Equation 5.5.8 frequency with wavelength | $$\frac{c}{\Delta\lambda_x} = \gamma \frac{c}{\lambda_0}$$ | **(5.5.10)** |
| Solve for wavelength | $$\Delta\lambda_x = \frac{\lambda_0}{\gamma}$$ | **(5.5.11)** |
| Length is the sum of the distances between atoms | $$L_o = \sum n_N \lambda_0$$ | **(5.5.12)** |

Length changes because wavelength contracts in X direction

$$\Delta L_x = \sum n_N \Delta\lambda_x \tag{5.5.13}$$

Subtitute Eq 5.5.11 into 5.5.13

$$\Delta L_x = \sum n_N \frac{\lambda_0}{\gamma} \tag{5.5.14}$$

Subtitute Eq. 5.5.12 into 5.5.14. **Length Contraction.**

$$\Delta L_x = \frac{L_o}{\gamma} \tag{5.5.15}$$

## 6. Conclusion

Today's classical and quantum equations are undoubtedly correct. Countless experiments have verified the accuracy of these equations from the energies of various atoms and molecules to the specific energy of a photon at various wavelengths. However, there remains a separation of equations for the subatomic (quantum mechanics) and for the world larger than the size of these atoms (classical mechanics).

The conclusion of this paper is that there is indeed one fundamental set of rules and equations that govern everything in the universe, regardless of size. In this view of the universe, all energy comes in the form of waves, either longitudinal or transverse forms. Further, various particles seen both in nature and in experiments are a result of a combination of wave centers, combining to form a particle, whose stability is dependent on the ability to have a core structure in which wave centers can reside at the nodes of a three-dimensional wave to maintain stability. It is proposed that the neutrino may be the fundamental wave center.

Since this view of particle physics is very different from currently accepted models, this paper had the challenge of not only matching existing data, but also providing an explanation and derivation of existing energy equations.

The following evidence was presented in support of the new, proposed energy wave equations:

- Calculated the energy and mass of lepton particles using the Longitudinal Energy Equation, which coincides with magic numbers also seen in atomic elements.
- Calculated the wavelengths of hydrogen orbital transitions, both ionization and transitions between shells. The same Transverse Wavelength Equation was used to calculate the electron Compton wavelength.
- Calculated the ionization energies of the first twenty elements using the Transverse Energy Equation, using different configurations of electrons in each element to prove that amplitude is the variable in the equation that governs transverse energy.
- Finally, the Orbital Equation was used to calculate the distances to each hydrogen orbit, including the correct calculation of the Bohr radius.

Following the presentation of this data in Section 1, a derivation and explanation of the equations were presented, concluding with a tie of these equations to current quantum and classical equations. Explanations were also provided for experiments that led to the quantum revolution, explaining the photoelectric effect and double slit experiments. In short, light is a wave but in packet form. While light is not a particle, as defined in this wave theory as a formation of one or more wave centers, the electron is a particle. The electron contains wave centers that reflect waves, which explains its confusing nature as appearing as both a particle and a wave.

This paper concludes that all energy comes from an energy wave equation and that classical and quantum energy equations are one - simply a difference of frequency or amplitude experienced by particles. Quantum jumps were further explained as the electron's movement between orbitals as it is both attracted and repelled by the nucleus, where its orbit is a gap in the forces because of wave cancellation.

There is sufficient data, with reasonable explanation, that these energy wave equations should be seriously considered. The fact that the neutrino may be the building block of other particles should also be considered. These findings provide the basis of a new, encouraging way to explain subatomic particles and their interactions.

There is potential work that may prove or expand upon the theory presented in this paper, such as:

- If all of the magic numbers from the Periodic Table of Elements hold true for leptons, there may be a neutrino at K=2 ($1.76 \times 10^{-17}$ joules). Locating this neutrino may provide additional proof.

- Determining the structure of the proton with both attracting and repelling forces would be further proof. It is assumed that there is a positron in the core and that repelling forces, perhaps electrons in the core of the proton, cancel at distances which become the atomic orbitals. Once the basic proton structure is validated for hydrogen, it can be expanded upon for all other elements to determine their orbitals.

- This paper has calculated all of the orbital energies for hydrogen and ionization of the first twenty elements for the first orbital. Further proof could build out models beyond the first orbital and also for elements beyond calcium.

# Appendix

## Aether: Michelson-Morley Experiment

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. 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.[22] Lorentz would later have the Lorentz contraction factor named after him, and matter has been proven to contract. In fact, Albert Einstein 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.[23] With the Lorentz factor considered, the results are what Michelson and Morley expected, which shows a phase shift in the light wave. The aether does exist. Without this factor considered, the results are what the Michelson-Morley experiment recorded, and why the aether was disregarded.

Fig. A.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.

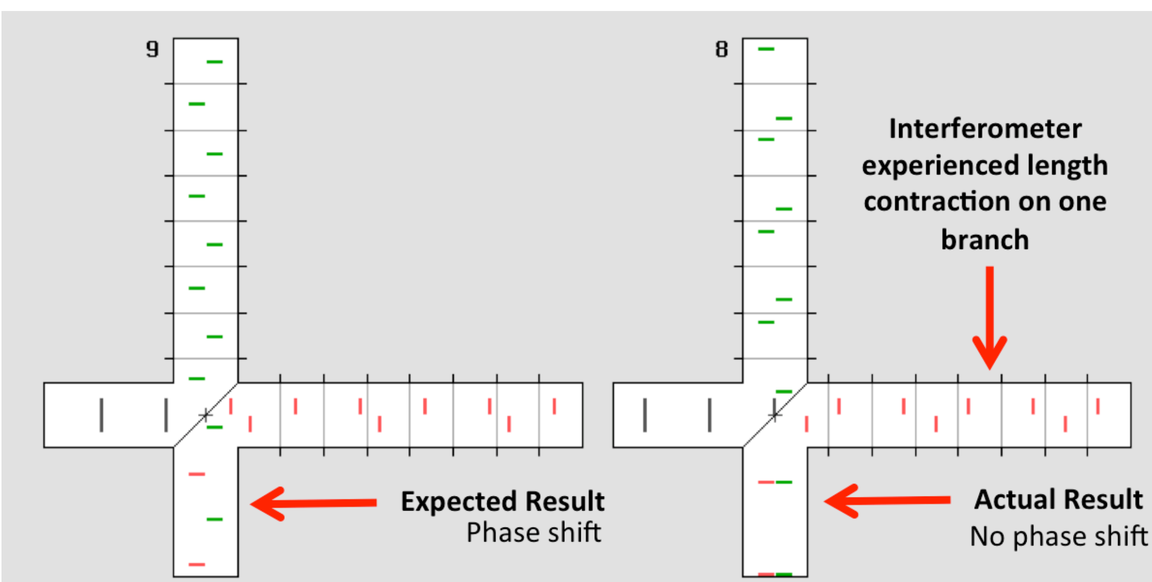



Fig A.1 – Michelson Interferometer

## Other Particle Rest Energies (non-Leptons)

It is not expected that the Longitudinal Energy Equation can be used for all particles in its current form, as it assumes amplitude is perfectly constructive, the resulting amplitude being K times $A_l$. This means that wave centers (possibly neutrinos) must be located at exact wavelengths apart from all other wave centers. Leptons, covered earlier, may fit into this criterion, as magic numbers might reflect geometrically stable shapes. However, not all particles can be expected to meet the same criteria and thus the calculations in Table A.1 have been put into this appendix.

Some of the remaining particles, many of which are created in particle accelerator labs, have been mapped to the closest value of K, if its standing waves are perfectly constructive. This is shown in the table below comparing the calculated rest energy (red) against the particle's CODATA rest energy (italics).

| **Core - Wave Centers (K)** | **30** | **39** | **44** | **47** | **49** | **51** | **54** | **55** |
|---|---|---|---|---|---|---|---|---|
| **Particle Name** | **Pion** | **Kaons** | **Proton** | **Xi** | **Xi (Res)** | **Strange D** | **Charmed Xi (Res** | **Ds3*(2860)** |
| **Calculated Rest Energy (GeV)** | **0.1344** | **0.5036** | **0.9237** | **1.287** | **1.587** | **1.940** | **2.585** | **2.835** |
| *CODATA Rest Energy (GeV)* | *0.1349* | *0.4970* | *0.9382* | *1.3140* | *1.5310* | *1.970* | 2.575 | *2.860* |

| **Core - Wave Centers (K)** | **56** | **57** | **62** | **63** | **107** | **110** | **117** |
|---|---|---|---|---|---|---|---|
| **Particle Name** | **Eta Charmed** | **Double Charmed** | **Charmed D** | **Bottom Xi** | **W Boson** | **Z Boson** | **Higgs Boson** |
| **Calculated Rest Energy (GeV)** | **3.103** | **3.392** | **5.173** | **5.606** | **79.86** | **91.73** | **125.0** |
| *CODATA Rest Energy (GeV)* | *2.980* | *3.510* | *5.366* | *5.8000* | *80.39* | *91.18* | *125.00* |

**Table A.1 –Particle Mass as Function of K**

## Acknowledgements

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

# References


[1] "Forces: Explained and Derived by Energy wave equations." Vixra. http://vixra.org/abs/1606.0112

[2] "Standard Model." Wikipedia. https://en.wikipedia.org/wiki/Standard_Model

[3] "Bohr Radius." Wikipedia. https://en.wikipedia.org/wiki/Bohr_radius

[4] "Rydberg Formula." Wikipedia. https://en.wikipedia.org/wiki/Rydberg_formula

[5] "Hydrogen Energy Levels." Hyperphysics. http://hyperphysics.phy-astr.gsu.edu/hbase/hyde.html

[6] "Multi-Electron Atoms." Phys.Utk.Edu. http://electron6.phys.utk.edu/phys250/modules/module%203/Multi-electron%20atoms.htm

[7] "Energy Levels of Electrons." SDSS.org. http://skyserver.sdss.org/dr1/en/proj/advanced/spectraltypes/energylevels.asp

[8] "Quantum Energy Levels in Atoms." CNX.org. http://cnx.org/content/m12451/latest

[9] "Molar Ionization Energies of the Elements." Wikipedia. http://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements

[10] "Molar Ionization Energies of the Elements." Wikipedia. http://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements

[11] "Michelson-Morley Experiment." Wikipedia. https://en.wikipedia.org/wiki/Michelson%E2%80%93Morley_experiment

[12] "Huygen-Fresnel Principle." Wikipedia. https://en.wikipedia.org/wiki/Huygens%E2%80%93Fresnel_principle

[13] "The Standard Model Part I." Real Clear Science. http://www.realclearscience.com/blog/2012/03/the-standard-model-part-i.html

[14] "Fundamental Physical Constants: Explained and Derived by Energy wave equations." Vixra. http://vixra.org/abs/1606.0113

[15] "Pair Production Process." Wikipedia. http://en.wikipedia.org/wiki/Pair_production

[16] "Neutrino Oscillation." Wikipedia. https://en.wikipedia.org/wiki/Neutrino_oscillation

[17] "Photoelectric Effect." The Physics Hypertextbook. http://physics.info/photoelectric/

[18] "Wave-Particle Duality." Wikipedia. https://en.wikipedia.org/wiki/Wave%E2%80%93particle_duality

[19] "Charge Radius – Proton." Wikipedia. http://en.wikipedia.org/wiki/Proton

[20] "Time Dilation." Wikipedia. http://en.wikipedia.org/wiki/Time_dilation

[21] "Length Contraction." Wikipedia. http://en.wikipedia.org/wiki/Length_contraction

[22] "Hendrik Lorentz." New World Encyclopedia. http://www.newworldencyclopedia.org/entry/Hendrik_Lorentz

[23] "The Michelson Interferometer." Rhthmodynamics. http://www.rhythmodynamics.com/Gabriel_LaFreniere/sa_Michelson.htm