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

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Summary

Subatomic particle energies and the relationship to photon energies are presented in this paper with a new methodology to explain and calculate the transfer of energy between particles and photons. A new energy wave equation is proposed that governs particle mass, motion and interaction.

Ultimately, particles and photons are derived from a single energy wave equation, yet they have two distinct forms, consisting of four fundamental constants. The forms are longitudinal and transverse, and the four constants are wave speed, wavelength, amplitude and density. The energy equations are further derived based on wave differences – amplitude and wavelength – that are the cause of particle formation and interactions with other particles that create forces.

Particle energies are calculated without the complexity of the Standard Model; photon energies are calculated without the need for the Rydberg constant and can support calculations well beyond hydrogen's photon energy levels. Furthermore, there is a link between particle and photon energies that can be described mathematically and explained logically to illustrate the transfer of energy from one to another.

The proposed equations in this paper have successfully:

- Calculated rest energies and masses of subatomic particles from the neutrino to Higgs boson
- Calculated photon ionization energies of the first twenty elements from hydrogen to calcium

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 antimatter collision. Interestingly, similarities were found between particle formation and atomic element formation.

These findings conclude that particles are made from fundamental building blocks of matter that reflect wave energy. 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.

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 including photon energies and wavelengths. 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.

This section provides a brief introduction of particle and photon energies calculated in this paper, along with the equations and constants used in the calculations. Section 2 provides detailed calculations and results. Section 3 includes the derivations of the equations and their explanations.

Particle Energy

Rest energy of subatomic particles are calculated using an equation that models longitudinal, standing wave energy, shown later in Eq. 1.1. It is 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. Whereas atomic elements are formed from protons (Z) as the building block, particles are assumed to consist of a combination of wave centers (K) as their building block. Wave centers are a special type of particle – closely resembling the properties of the neutrino – that reflect longitudinal waves to become a standing wave.

Particles were arranged by wave centers and given a name *particle number*, similar to atomic number for atomic elements. Atomic elements in the Periodic Table of Elements range from 1 (hydrogen) to 118 (ununoctium) and arranging these elements by atomic mass yields a linear solution when graphed against atomic number.

Arranging subatomic particles by their rest mass does not yield a linear solution like atomic elements, which is why a fundamental particle has not been established as the building block for all of the known particles. However, when considering a fundamental building block to the fourth power (K^4), which will be explained later in Section 3, particle energy can be linearized similar to atomic elements.

Fig 1.1 linearizes particle energies by the newly-introduced particle number (K). The particle's known rest energy (measured in eV – electronvolts) is divided by the fourth power (K^4) and a summation equation introduced later in Section 2.[1] [2] After plotting the particle energies from the lightest particle (neutrino) to the heavy Higgs boson, it is found that:

- Particle energies are nearly linear after dividing by the fourth power of the particle number, similar to atomic elements.
- The particle number ranges from 1 to 117, similar to atomic numbers ranging from 1 to 118.
- The lepton particles (neutrinos and electrons) fall at magic numbers shared with atomic elements 2, 8, 20, 28 and 50. Only the number 2 is a magic number that is not mapped to a currently known particle.

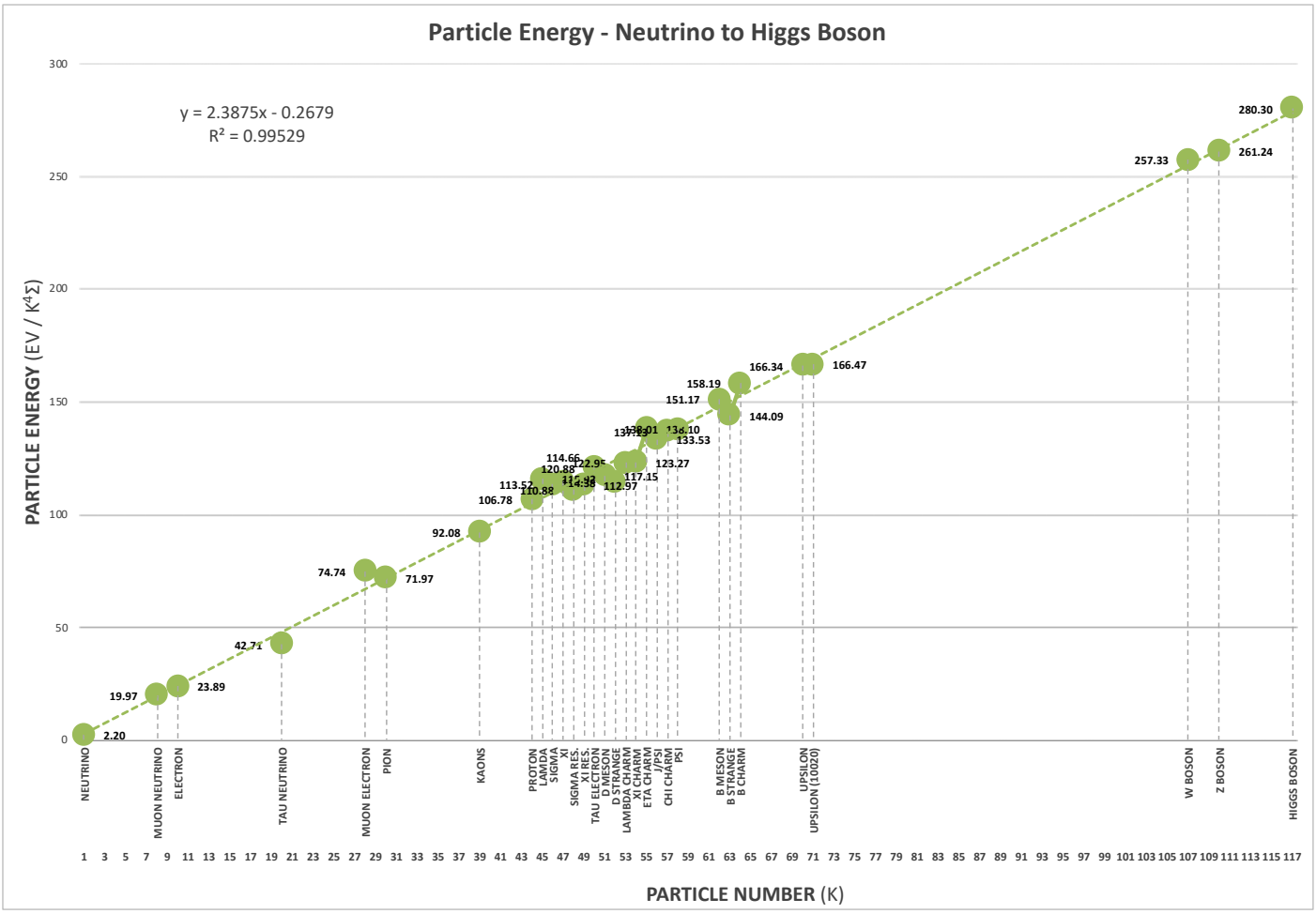


Fig 1.1 – Particle energy linearized as a function of particle number (K) to the fourth power.[1 2]

In addition to comparisons between particles and atomic elements, the equation for longitudinal wave energy that is used to calculate the rest energy of particles, is extended to:

- Calculate the spherical, longitudinal energy within an atom that will eventually be converted to the transverse energy of photons. This energy is found to exactly match photon energy, described in detail in Section 3.2.
- Derive the equations for forces in the *Forces* paper, in which the particle force calculations for both electromagnetism and gravity have no difference compared to measured values (0.000%).[3]

This gives confidence that the equation to calculate particle energies and predict future particles is based on longitudinal wave energy. The Longitudinal Energy Equation is introduced to calculate particle energy later in this section.

Photon Energy

Beyond its standing wave structure, a particle still has longitudinal wave energy but it transitions from standing waves to longitudinal traveling waves. This longitudinal wave energy decreases with the square of the distance from the particle.

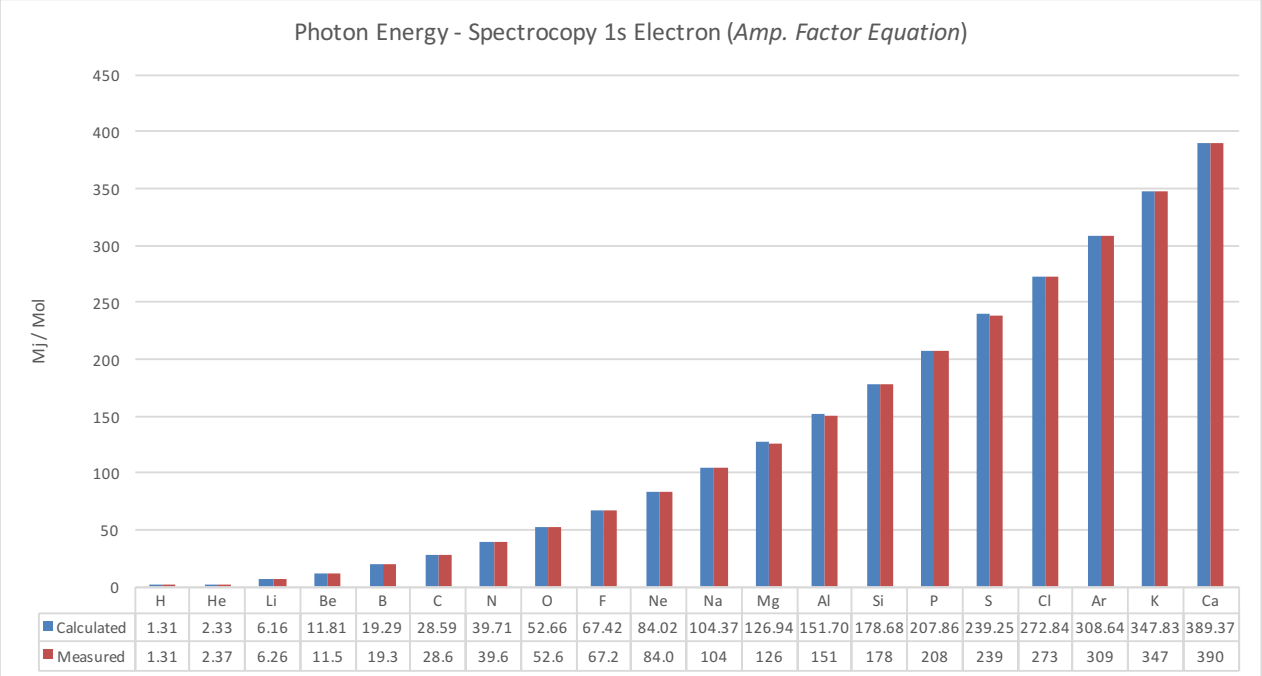
A vibrating particle will create a transverse wave perpendicular to the direction of vibration, creating photons. The energy of two photons – each traveling in opposite directions from the particle – is calculated in this paper to be

exactly equal to the longitudinal wave energy between two particles. The vibrating particle (e.g. electron) is affected by other particles in its vicinity (e.g. protons) and the wave amplitude difference causes its motion.

Since photon energy is a transfer of longitudinal wave energy, a photon's energy can be calculated by knowing:

- The distance between the vibrating particle and the particle responsible for its vibration. For an electron in an atomic orbital, this is the radius (r) from the atom's nucleus.
- The wave amplitude difference between the vibrating particle and surrounding particles. A new variable has been assigned as a measurement of this constructive or destructive wave interference called the amplitude factor.

Photon energies were calculated using an energy equation for transverse waves with two variables: distance and wave amplitude factor. This methodology can be used for photons created by or absorbed by any atom. It can also be used for photon energies in the annihilation process of particles such as the combination of an electron and positron. In Fig. 1.2, the photon energies of the 1s electron (first orbital) are calculated for the first twenty elements from hydrogen to calcium, matching results from photoelectron spectroscopy experiments. Additional calculations and comparisons against other atomic arrangements are provided in Sections 2 and 3.



	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca
Calculated	1.31	2.33	6.16	11.81	19.29	28.59	39.71	52.66	67.42	84.02	104.37	126.94	151.70	178.68	207.86	239.25	272.84	308.64	347.83	389.37
Measured	1.31	2.37	6.26	11.5	19.3	28.6	39.6	52.6	67.2	84.0	104	126	151	178	208	239	273	309	347	390

Fig. 1.2 – Photon energy absorbed for ionization of the 1s electron. Calculated results use the Amplitude Factor Equation - 1s Orbital Ionization and are compared with measured results from photoelectron spectroscopy results.[4]

The Transverse Energy Equation is introduced to calculate photon energies later in this section.

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

Notation	Meaning
K_e	Particle wave center count (e – electron)
λ_l λ_t	Wavelength (l – longitudinal wave, t – transverse wave)
g_λ g_A g_p	g-factor (λ – electron orbital g-factor, A – electron spin g-factor, p – proton g-factor)
F_g, F_m	Force (g - gravitational force, m – magnetic force)
$E_{(K)}$	Energy (K – particle wave center count)

Table 1.1.1 – Energy Wave Equation Notation

Constants and Variables

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

Symbol	Definition	Value (units)
Wave Constants		
A_l	Amplitude (longitudinal)	$9.215405708 \times 10^{-19}$ (m)
λ_l	Wavelength (longitudinal)	$2.854096501 \times 10^{-17}$ (m)
ρ	Density (aether)	$3.859764540 \times 10^{22}$ (kg/m^3)
c	Wave velocity (speed of light)	299,792,458 (m/s)
Variables		
δ	Amplitude factor	variable - *dimensionless*
K	Particle wave center count	variable - *dimensionless*
Q	Particle count in a group	variable - *dimensionless*
Particle Constants		
K_e	Electron particle count	10 - *dimensionless*
O_e	Electron outer shell multiplier	2.138743820 – *dimensionless*
g_λ	Electron orbital g-factor (*revised*)	0.9873318320 – *dimensionless*

g_A	Electron spin g-factor (*revised*)	0.9826905018 – *dimensionless*
g_p	Proton orbital g-factor (*revised*)	0.9898125300 – *dimensionless*

Table 1.1.2 – Energy Wave Equation Constants and Variables

Method for calculating the values of the constants

The method used for deriving and calculating each of the constants is found in the *Fundamental Physical Constants* paper.[5] The values may continue to be refined, and if so, will be posted online at: energywavetheory.com/equations.

1.2. Energy Wave Equations

For the purpose of understanding the energy wave equations in this section, it is accepted that there is a medium for the transmission of wave energy in the universe and that it consists of only two things: 1) a sub-particle that transfers wave energy in the direction of wave travel (hereafter called an aether granule), and 2) a sub-particle that reflects wave energy in the opposite direction of wave travel (hereafter called a wave center). Particles are created from wave centers in formation that consist of longitudinal in-waves and out-waves that form standing waves. Finally, particle motion, particularly a vibration, creates a transverse wave. The following assumptions are the foundation of the Energy Wave Equations.

Energy Wave Theory Assumptions

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.[6] Amplitude is reduced at the square of distance from the source and experiences constructive and destructive wave interference.
2. Aether granules transfer energy to the next granule in the direction of wave travel.
3. Aether wave centers reflect energy in the opposite direction of wave travel, creating standing waves for a given distance as a combination of in-waves and reflected out-waves.
4. Aether wave centers may assemble in formation to create particles with various energy levels via constructive and destructive wave interference.
5. Aether wave centers move to minimize amplitude on the wave, thereby preferring the node position of the wave.
6. Wave energy is proportional to amplitude, wavelength, wave speed and density of a defined volume.

Energy Wave Equations

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

Longitudinal Energy Equation

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta}{r} - \frac{\delta}{r_0} \right) \tag{1.2.2}$$

Transverse Energy Equation

$$\lambda_t = \frac{16 K_e^4 A_l}{3\lambda_l} \left(\frac{1}{\frac{\delta}{r} - \frac{\delta}{r_0}} \right) \tag{1.2.3}$$

Transverse Wavelength Equation

Energy Wave Equations – Complete Form

The complete form of the equations that represent particle energy as longitudinal in-waves and out-waves, to form standing waves, are presented here in this section. These equations are not used for calculations in this paper but are used for the derivation of the Longitudinal Energy Equation (Eq. 1.2.1) and are also used for particles traveling at relativistic speeds. The additions for relativistic speeds into the equation first appeared in *The Relation of Particle Relativistic Energy to Particle Wavelength* paper and are added here for consistency.[7]

The longitudinal in-wave of a particle traveling at velocity (v):

$$E_{l(in)} = \frac{1}{2}\rho\left(\frac{4}{3}\pi (K_e\lambda_l)^3\right)\left(\frac{c}{\lambda_l\sqrt{\left(1+\frac{v}{c}\right)}}\frac{(K_e A_l)^3}{(K_e\lambda_l)^2}\right)\left(\frac{c}{\lambda_l\sqrt{\left(1-\frac{v}{c}\right)}}\frac{(K_e A_l)^3}{(K_e\lambda_l)^2}\right) \tag{1.2.5}$$

Longitudinal In-Wave Energy

The longitudinal out-wave of a particle traveling at velocity (v):

$$E_{l(out)} = \frac{1}{2}\rho\left(\frac{4}{3}\pi (K_e\lambda_l)^3\right)\left(\frac{c}{\lambda_l\sqrt{\left(1+\frac{v}{c}\right)}}\frac{(K_e A_l)^2 K_e (A_l - A_l\sqrt{\alpha_{Ge}})}{(K_e\lambda_l)^2}\right)\left(\frac{c}{\lambda_l\sqrt{\left(1-\frac{v}{c}\right)}}\frac{(K_e A_l)^2 K_e (A_l + A_l\sqrt{\alpha_{Ge}})}{(K_e\lambda_l)^2}\right) \tag{1.2.6}$$

Longitudinal Out-Wave Energy

2. Calculations and Results

This section details the steps to reproduce the calculations using the energy wave equations. Explanations of the energy wave equations are reserved for Section 3.

2.1. Particle Energy

The Longitudinal Energy Equation (Eq. 1.2.1) was used to calculate the rest energy of many particles. 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.

Neutrino

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 is estimated with a range that is 2.2 eV at its highest according to the Standard Model.[8] The calculated value, shown below, is just slightly larger at 2.4 eV (3.8280 x 10^{-19} joules).

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

Calculated Value: 3.8280 x 10^{-19} joules (kg m^2/s^2)

Electron

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 8.1871 x 10^{-14} joules is calculated, which is no difference (0.000%) to that level of digits from the CODATA value of the electron in joules.

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

Calculated Value: 8.1871 x 10^{-14} joules (kg m^2/s^2)

Particle rest energies were calculated using values K=1 to K=118 to represent the wave center count within the core of a particle. Then, known particles were mapped to the closest value of K based on their Particle Data Group (PDG) energy level and the calculated energy level of K. An example is shown in Table 2.1.1 for the lepton family of particles and the Higgs boson.

Wave Centers (K)	1	8	10	20	28	50	117
Particle Name	Neutrino	Muon Neutrino	Electron	Tau Neutrino	Muon Electron	Tau Electron	Higgs Boson
Calculated Rest Energy (J)	3.83E-19	2.61E-14	8.19E-14	2.78E-12	1.52E-11	2.81E-10	2.00E-08
PDG Rest Energy (J)	*3.52E-19*	*2.72E-14*	*8.19E-14*	*2.48E-12*	*1.70E-11*	*2.85E-10*	*2.01E-08*

Table 2.1.1 Calculated particle rest energy using the Longitudinal Energy Equation; Leptons and Higgs boson are compared to particle PDG energy values in joules.

Linear Solution to Particle Energy

In Fig. 1.1, particle energies where plotted in a linear solution from the neutrino to the Higgs boson to demonstrate that particles have features similar to the construction of atomic elements. This is achieved by dividing a particle's rest energy by a denominator shown in Eq. 2.1.3.

$$K^4 \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4} \tag{2.1.3}$$

The Longitudinal Energy Equation (Eq. 1.2.1) which describes particle energy is raised to the fifth power of the particle wave center count (K^5). The explanation and derivation is upcoming in Section 3. In Eq. 2.1.4, a modified energy value for the purpose of plotting contains the Longitudinal Energy Equation in the numerator and Eq. 2.1.3 in the denominator. After simplification to become Eq. 2.1.5, the solution is now linear as a function of K (with the exception of K in the equation all of the remaining components are constant).

$$E' = \frac{\frac{4\pi\rho K^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4}}{K^4 \sum_{n=1}^{K} \frac{n^3 - (n-1)^3}{n^4}} \tag{2.1.4}$$

$$E' = \frac{4\pi\rho A_l^6 c^2}{3\lambda_l^3} (K) \tag{2.1.5}$$

Note: Results are in joules. The energy values plotted in Fig. 1.1 and Fig 2.1.1 are in eV. The conversion is 6.2415 x 10^{18} electronvolts (eV) per joule. For example, using Eq. 2.1.5, the electron is calculated to be 3.828 x 10^{-18} * 6.2415 x 10^{18} = 23.89. This is the electron value that is used in Fig. 1.1.

Plotting Particle Energy (Modified by Eq. 2.1.3) vs Particle Number

The known PDG rest energy values of particles (in eV) were divided by Eq. 2.1.3 and plotted with the modified particle energy value and the particle wave center count (K). Some particles had overlapping particle numbers

(particularly around particle numbers 44 to 60 where there is a cluster that is found from proton collision experiments). When this occurred, the neutral value of the closest particle was used (e.g. neutral kaon vs charged kaon).

This was displayed earlier in Fig. 1.1 for particles ranging from the lowest-known energy value (neutrino) to the largest known value (Higgs boson). Now, it is plotted again in Fig 2.1.1 with greater detail for the first 50 particles, from the neutrino to tau electron.

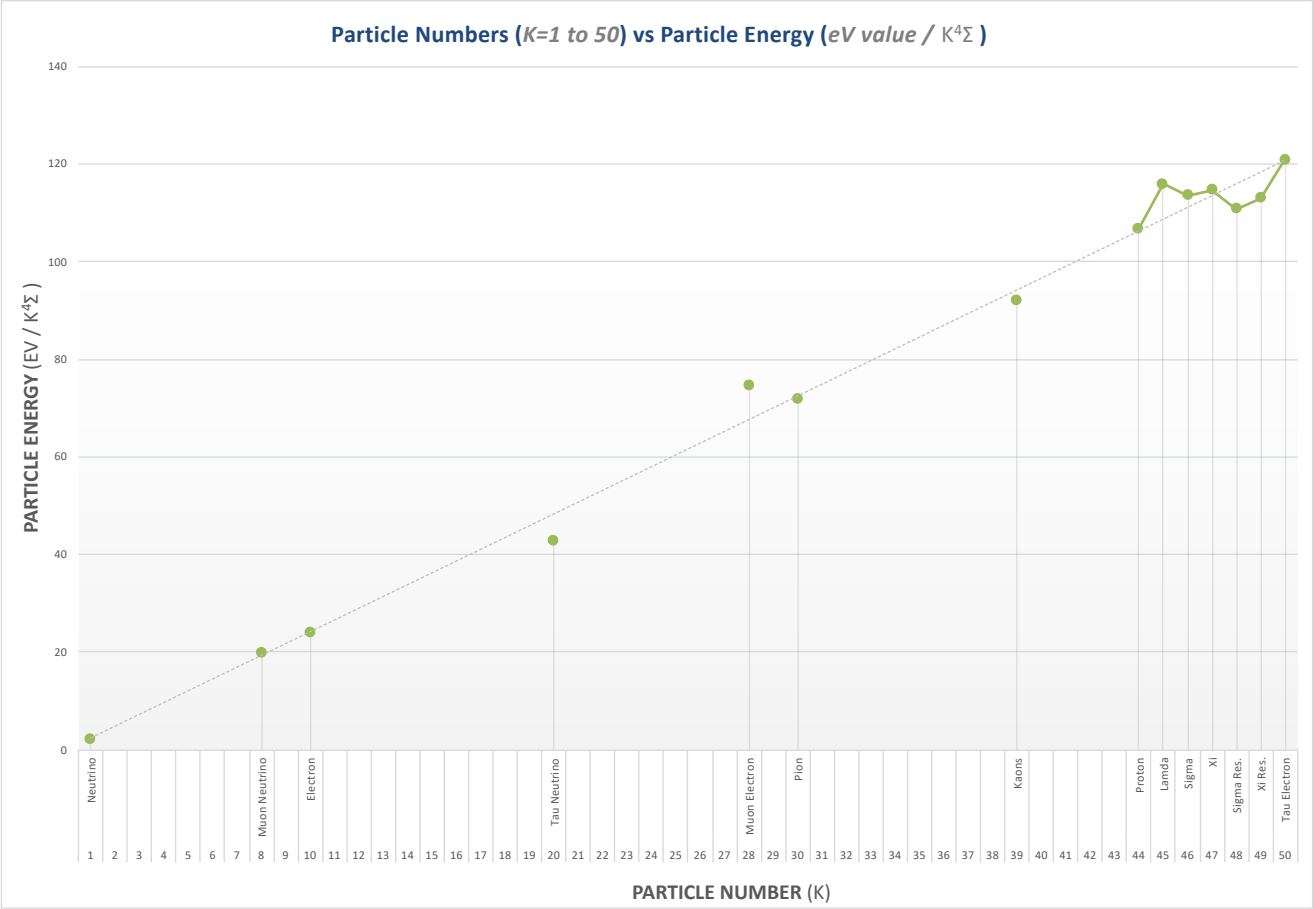


Fig. 2.1.1 Plotting particle energy (modified by Eq. 2.1.3) vs particle number (K). Leptons appear at magic numbers that are also seen in atomic elements: 2, 8, 20, 28, 50.

With the exception of the proton, which is known to be a composite particle consisting of smaller particles, the other particles that appear in nature are in the lepton family of particles, even if they rapidly oscillate or decay into other particles. They appear at magic numbers 8 (muon neutrino), 20 (tau neutrino), 28 (muon electron) and 50 (tau electron). The first five magic numbers for atomic elements, which represents greater stability relative to other elements is: 2, 8, 20, 28 and 50. In this sequence, only particle number 2 (K=2), is an undiscovered particle which could be a lepton.

2.2. Photon Energy

In Fig 1.2, the photon energy required to ionize the 1s electron was calculated and compared against photoelectron spectroscopy results. This section details example calculations and displays the results of further atomic configurations of electrons being ionized from the first orbital.

Calculations are performed using the Transverse Energy Equation (Eq. 1.2.2) and require knowing the amplitude factor (δ) and the radius (r) to the electron being ionized. Hydrogen is the simplest atomic element with an amplitude factor of one (δ=1) due to one proton and one electron, and the first orbital is a known radius known as the Bohr radius. Other configurations of atoms and the methodology to calculate amplitude factors and radii is described in Section 3.

Hydrogen Photon Energy – 1s (joules)

The Transverse Energy Equation (Eq. 1.2.2) is shown below in Eq. 2.2.1 with an initial radius of the first orbital – known as the Bohr radius (a_0) and a final radius that is infinity (∞) as the electron is ionized and is no longer in the atom. Substituting an amplitude factor of one (δ=1) for hydrogen and the Bohr radius (a_0=5.2918 x 10^{-11} m), the Rydberg unit of energy constant is found: 2.1799 x 10^{-18} joules. A negative sign in the final calculated value indicates a photon is absorbed by the atom; a positive sign would have indicated a photon was created. Note that the Bohr radius is another constant that can be derived from wave constants and is also calculated with 23 other physics constants in *Fundamental Physical Constants*.

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{1}{\infty} - \frac{1}{a_0}\right) \qquad \textbf{(2.2.1)}$$

Calculated Value: -2.1799 x 10^{-18} joules (kg m^2/s^2)

Hydrogen Photon Energy – 1s (MJ/mol)

Many experimental results are presented as megajoules per mol. The conversion uses **Avogadro's number (N_A)** for units per mole (6.02214 x 10^{23}) and 1 x 10^6 to convert from joules to megajoules. The same calculation for hydrogen in Eq. 2.2.1, is now expressed in MJ/mol in Eq. 2.2.2.

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{1}{\infty} - \frac{1}{a_0}\right)\left(\frac{N_A}{10^6}\right) \qquad \textbf{(2.2.2)}$$

Calculated Value: -1.31 MJ/mol

Photon Energies (H to Ca) – 1s

The Transverse Energy Equation includes two variables: electron distance and wave amplitude factor. If both variables are known, the equation can be used for any atom. For the first orbital (1s) of the first 20 elements (H to Ca), a simple pattern emerges that allows one variable to be calculated: the amplitude factor. The distance can then be set to the Bohr radius (a_0), simplifying the calculation. This approach only works for the first orbital of the first 20 elements. Calculations for other configurations require determining both variables.

As an example, heavily ionized neon (Ne^{8+}) is calculated using the Amplitude Factor Equation from Section 3.4, Eq. 3.4.1. This equation can be used for ionized elements that contain one or two electrons in the first orbital (1s) when the electron distance is set to the Bohr radius, simplifying calculations. Using Eq. 3.4.1, it is:

$$\delta_{Ne\text{“}8+\text{”}} = \left(10 - \frac{4}{3}\left(\frac{(2-1)}{2} + \frac{0}{8} + \frac{1}{2}\left(\frac{0}{8}\right) + \frac{1}{3}\left(\frac{0}{8}\right)\right)\right)^2 \qquad \textbf{(2.2.3)}$$

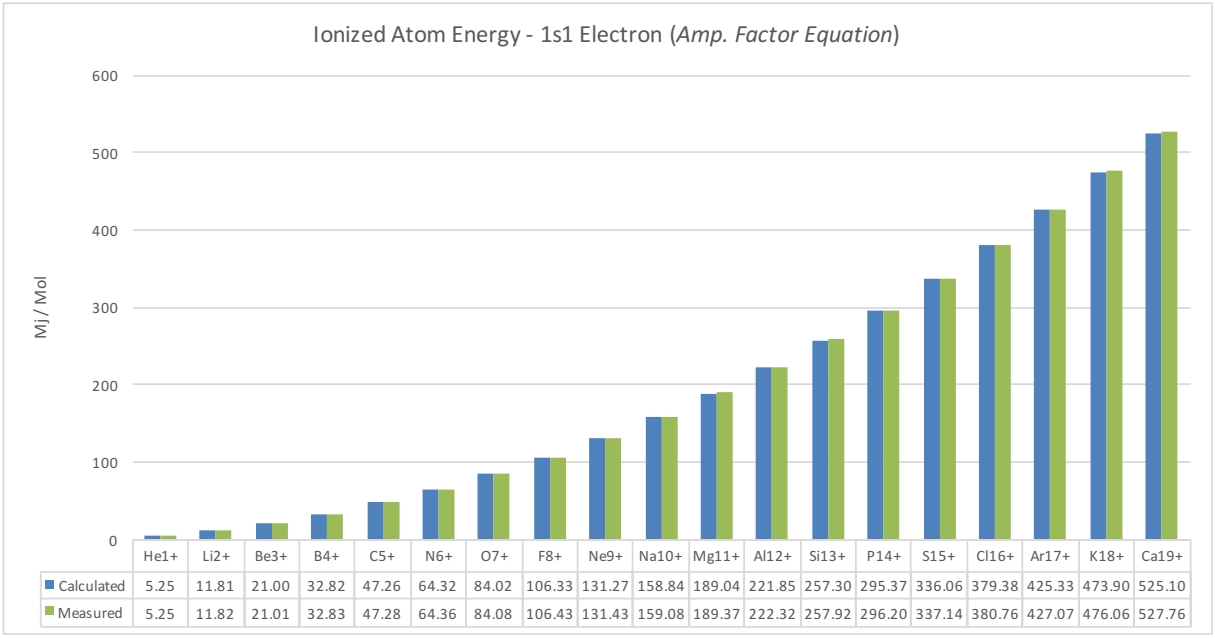
Calculated Value: 87.111

Using the Transverse Energy Equation (Eq. 1.2.2) and converting to MJ/mol using Avogadro's number (N_A), the following values are substituted: a_0 is the Bohr radius (5.2918 x 10^{-11} m) and the modified amplitude factor δ_{Ne8+} is 87.111 from Eq. 2.2.3.

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta_{Ne\text{“}8+\text{”}}}{\infty} - \frac{\delta_{Ne\text{“}8+\text{”}}}{a_0}\right)\left(\frac{N_A}{10^6}\right) \qquad \textbf{(2.2.4)}$$

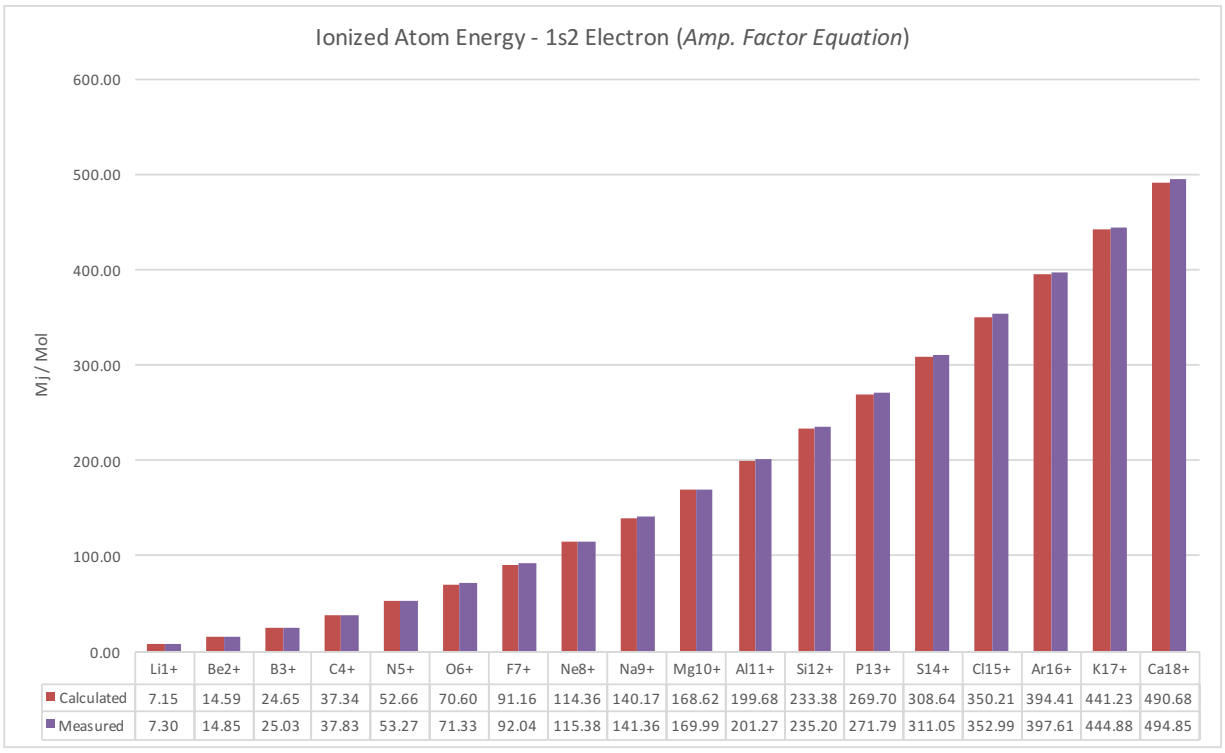
Calculated Value: -114.36 MJ/mol

Using the method described above, the values for heavily ionized elements with only one electron in the first orbital ($1s^1$) that is ionized were calculated using the steps above and charted in Fig. 2.2.1 for the first twenty elements. Similar steps were taken for ionized elements containing two electrons in the first orbital ($1s^2$) and charted in Fig 2.2.2.



	He1+	Li2+	Be3+	B4+	C5+	N6+	O7+	F8+	Ne9+	Na10+	Mg11+	Al12+	Si13+	P14+	S15+	Cl16+	Ar17+	K18+	Ca19+
Calculated	5.25	11.81	21.00	32.82	47.26	64.32	84.02	106.33	131.27	158.84	189.04	221.85	257.30	295.37	336.06	379.38	425.33	473.90	525.10
Measured	5.25	11.82	21.01	32.83	47.28	64.36	84.08	106.43	131.43	159.08	189.37	222.32	257.92	296.20	337.14	380.76	427.07	476.06	527.76

Fig. 2.2.1 Photon energy absorbed for ionization of the $1s^1$ electron of an ionized element. Calculated results use the Amplitude Factor Equation - 1s Orbital Ionization and are compared with measured results.[9]



	Li1+	Be2+	B3+	C4+	N5+	O6+	F7+	Ne8+	Na9+	Mg10+	Al11+	Si12+	P13+	S14+	Cl15+	Ar16+	K17+	Ca18+
Calculated	7.15	14.59	24.65	37.34	52.66	70.60	91.16	114.36	140.17	168.62	199.68	233.38	269.70	308.64	350.21	394.41	441.23	490.68
Measured	7.30	14.85	25.03	37.83	53.27	71.33	92.04	115.38	141.36	169.99	201.27	235.20	271.79	311.05	352.99	397.61	444.88	494.85

Fig. 2.2.2 Fig. 2.2.1 Photon energy absorbed for ionization of the $1s^2$ electron of an ionized element. Calculated results use the Amplitude Factor Equation - 1s Orbital Ionization and are compared with measured results.[9]

Photon Energies – Any Configuration

The example calculations in this section provide proof of the Transverse Wave Equation but have simplified the calculations to one variable for the first orbital from H to Ca. Other calculations require both variables, knowing both electron distance and the wave interference affecting the electron (amplitude factor).

Over 250 photon energies have been calculated using the Transverse Wave Equation and compared to experimental results. The results, along with the steps to calculate electron distance and wave interference for various atomic configurations is detailed and separated in a paper titled *Atomic Orbitals*.[10]

2.3. Photon Wavelength

Two examples are provided in this section for the calculation of photon wavelengths. The first is an ionization of an electron that leaves the atom. The second is the transition of an electron between two orbitals. To find photon wavelengths, the Transverse Wavelength Equation is used (Eq. 1.2.3). Similar to photon energies (Section 2.2), there are two variables: electron distance and amplitude factor. Whereas Section 2.2 simplified calculations to only amplitude factor, in this section it will be simplified to only the distance variable. Hydrogen is used which has an amplitude factor of one. For calculations of photon wavelengths beyond hydrogen, refer to the *Atomic Orbitals* paper for details of calculating both electron distance and amplitude factor.

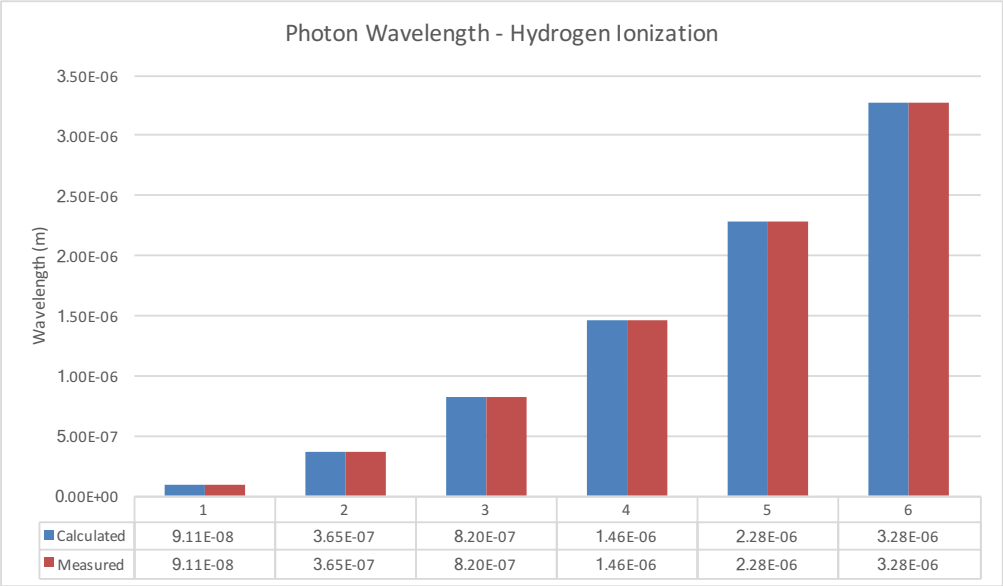
Hydrogen Photon Wavelength – 1s (Ionization)

To calculate the photon wavelength of ionization, the Transverse Wavelength Equation (Eq. 1.2.3) is used where the final distance is set to infinity. For hydrogen, it is a single proton and electron and the amplitude factor is one (δ_H=1). For hydrogen's first orbital (1s), the electron distance is known to be the Bohr radius (a_0).

$$\lambda_t = \frac{16K_e^4 A_l}{3\lambda_l} \frac{1}{\left(\frac{\delta_H}{\infty} - \frac{\delta_H}{a_0}\right)} \qquad \textbf{(2.3.1)}$$

Calculated Value: -9.1127 x 10^{-8} m

These steps were reproduced for hydrogen for the ground state (1s) to excited states (orbitals 2s to 6s) and charted against measured results in Fig. 2.3.1, matching experimental results.



	1	2	3	4	5	6
Calculated	9.11E-08	3.65E-07	8.20E-07	1.46E-06	2.28E-06	3.28E-06
Measured	9.11E-08	3.65E-07	8.20E-07	1.46E-06	2.28E-06	3.28E-06

Fig. 2.3.1 Hydrogen photon wavelengths – ionization [11]

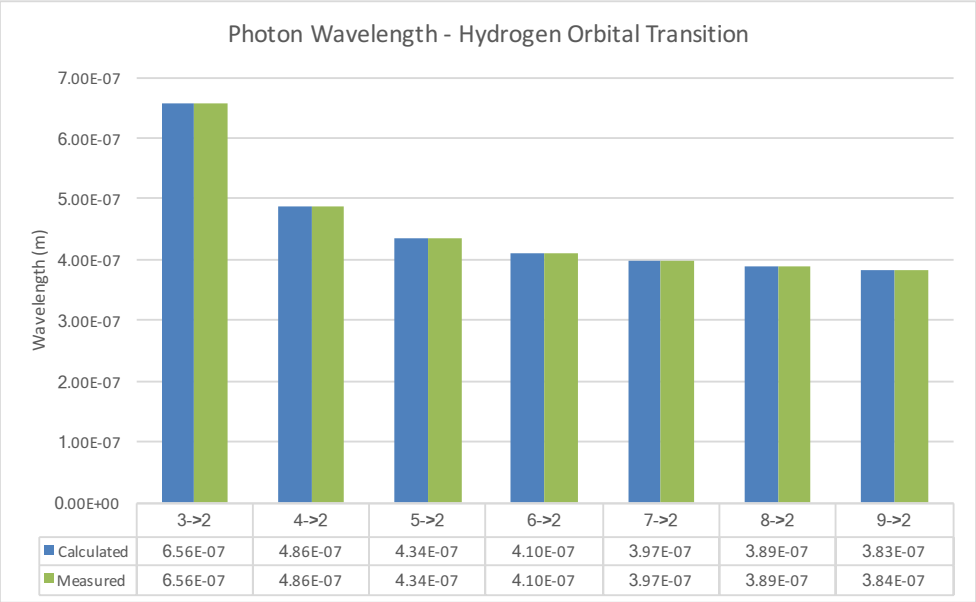
Hydrogen Photon Wavelength – Orbital Transition from 3s to 2s

The same equation and steps can be used to calculate the photon that is emitted by an atom when an electron transitions to a lower energy state. For example, the following uses the Transverse Wavelength Equation (Eq. 1.2.3), substituting the electron distances from the 3s orbital to the 2s orbital for hydrogen. It is $3^2 * a_0$ (Bohr radius) and $2^2 * a_0$ for the distances respectively. Since it is hydrogen, the amplitude factor remains the same (δ_H=1).

$$\lambda_t = \frac{16K_e^4 A_l}{3\lambda_l} \frac{1}{\left(\frac{\delta_H}{(2)^2 a_0} - \frac{\delta_H}{(3)^2 a_0} \right)} \qquad \textbf{(2.3.2)}$$

Calculated Value: 6.5611×10^{-7} m

These steps were repeated for the transition of an electron in hydrogen from various orbitals to the second orbital (2s). The naming has convention of initial orbital -> final orbital (e.g. 3->2). The calculated wavelengths are charted in Fig. 2.3.2 and compared against measured results.



	3->2	4->2	5->2	6->2	7->2	8->2	9->2
Calculated	6.56E-07	4.86E-07	4.34E-07	4.10E-07	3.97E-07	3.89E-07	3.83E-07
Measured	6.56E-07	4.86E-07	4.34E-07	4.10E-07	3.97E-07	3.89E-07	3.84E-07

Fig. 2.3.2 Hydrogen photon wavelengths – transition between orbitals (initial->final).[12]

Photon Wavelengths – Any Configuration

Similar to photon energies in Section 2.2, the wavelengths of photons of complex atom configurations require knowing the electron distance and wave amplitude factor variables. The calculations of these variables, and their methods, are provided in the *Atomic Orbitals* paper.

3. Deriving and Explaining the Energy Wave Equations

In 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 fundamental wave energy equation in the following form. Frequency (f) is otherwise expressed as c / λ, which leads to Eq. 3.2.

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

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

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.

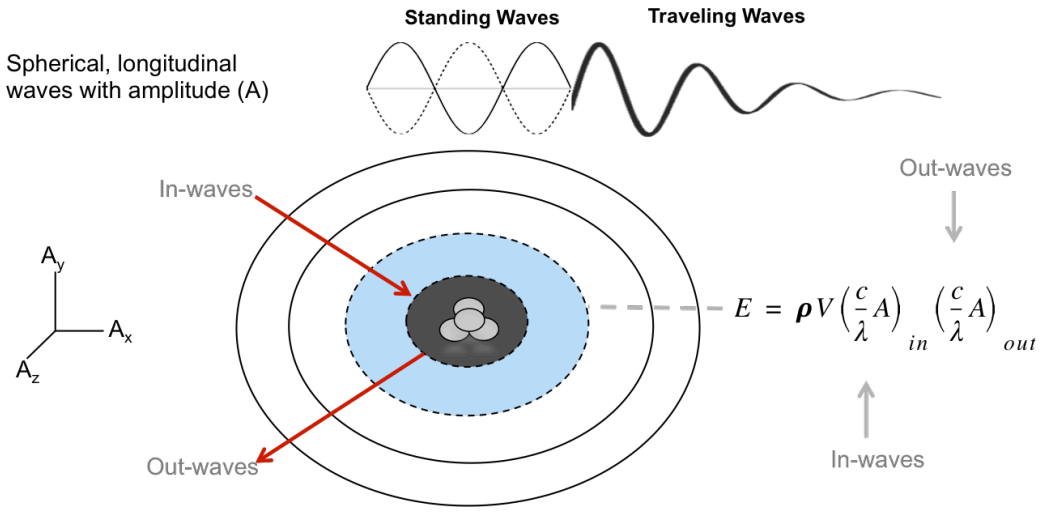


Fig 3.1 – Longitudinal Waves

The energy wave 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.

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

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 contains stored energy (standing waves).

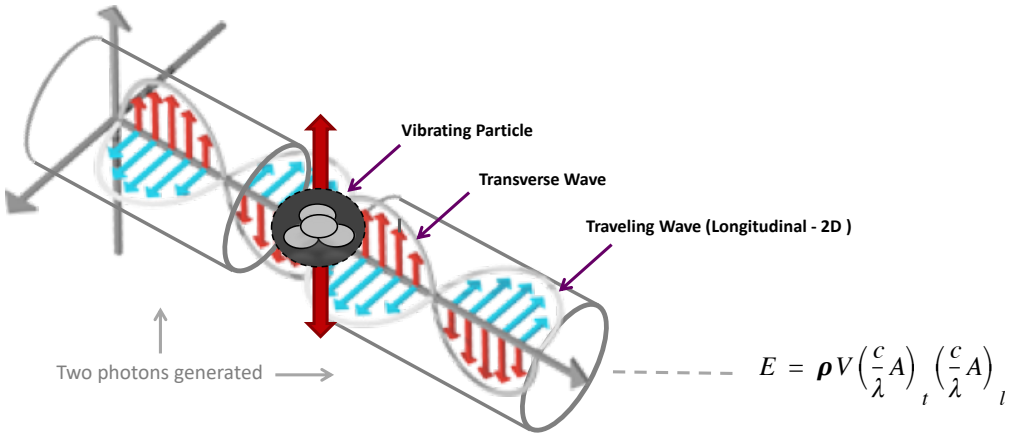


Fig 3.2 – Transverse Waves

$$E = \rho V \left(\frac{c}{\lambda} A\right)_{t} \left(\frac{c}{\lambda} A\right)_{l} \tag{3.4}$$

In Fig. 3.2, a particle is shown to create **two photons** with a transverse wave along with its longitudinal, traveling wave (it no longer has a standing wave like Fig. 3.1). In most experiments that involve the creation of a photon, only **one photon** is found leaving the atom. The second photon is responsible for the recoil of the atomic nucleus and is absorbed before leaving the atom. The angles of photons and electrons are discussed in the *Photons* paper for various experiments, including: spontaneous emission, stimulated emission, annihilation, orbital transition, photoelectric effect, Compton effect and pair production.[13]

3.1. Particle Rest Energy - 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 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 decreases with the square of distance, with each wavelength, or shell (n).
- 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.
- Particle energy 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 antineutrinos 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 antineutrino will be destructive due to wave phase difference.

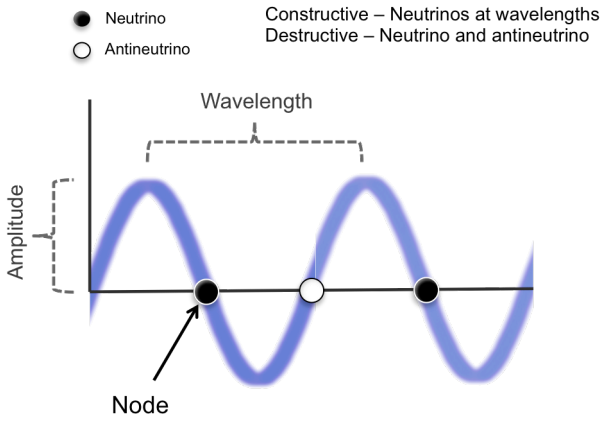


Fig 3.1.1 – Nodes and neutrino placement

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.

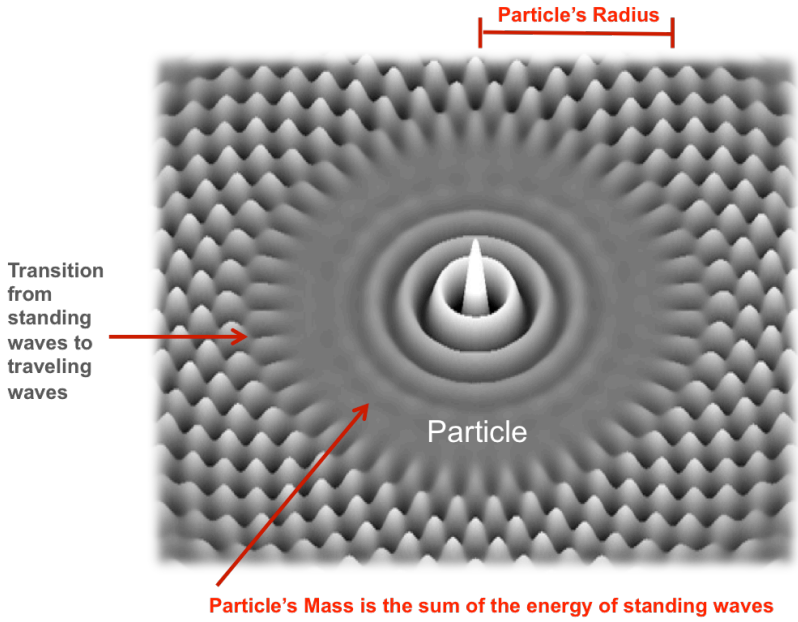


Fig 3.1.2 – Particle radius and mass

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.

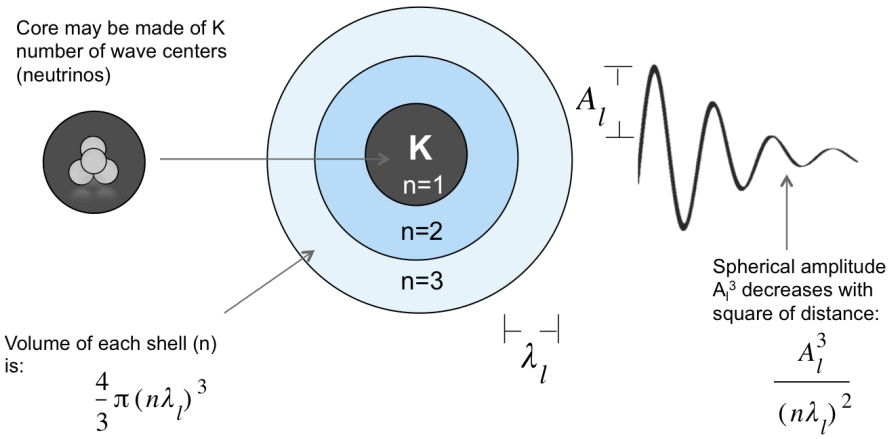


Fig 3.1.3 –Spherical longitudinal waves originating from a particle

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.

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

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

$$r_{core} = K\lambda_l \tag{3.1.3}$$

Amplitude is also affected by the particle 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.

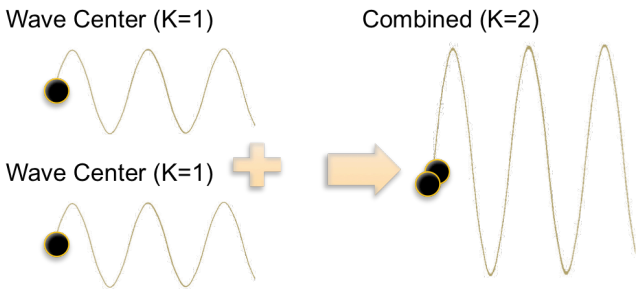


Fig 3.1.4 –Constructive Waves

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.

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

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

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.

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

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

Longitudinal Energy Equation

Notes:

1. Standing waves complete at radius $K^2\lambda_l$ when amplitude decreases to the point where it matches in-wave amplitude, but longitudinal energy continues on beyond it as traveling waves. This becomes the foundation of the electric and magnetic forces summarized in the *Forces* paper.
2. The Longitudinal Energy Equation is used to determine the energy of a particle at rest. When a particle is in motion, the particle's velocity needs to be considered. For low velocities, the Longitudinal Energy Equation is sufficient. At relativistic speeds closer to the speed of light, the complete form of the equation needs to be used. The longitudinal in-wave energy (Eq. 1.2.5) and out-wave energy (Eq. 1.2.6) are added together to determine the particle energy at relativistic speeds. When velocity is zero, these equations derive to the Longitudinal Energy Equation. More information about this derivation is found in *The Relation of Relativistic Energy to Particle Wavelength* paper.

Electron

The electron particle energy (E_e) and radius (r_e) are calculated as examples using the equations from this section (from Eqs. 3.1.8 and 3.1.6 respectively) where the particle number is ten (K=10). The shorthand notation for electron energy is used where $\mathbf{O_e}$ replaces the summation of shells (n) in the Longitudinal Energy Equation, as shown in Eq. 3.1.9. It is used only for **readability purposes** for the electron. Note that the electron radius uses the electron orbital g-factor which is explained in the *Fundamental Physical Constants* paper.

$$O_e = \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(3.1.9)}$$

$$E_e = \frac{4\pi\boldsymbol{\rho} K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} = 8.1871 \cdot 10^{-14} \left(\frac{kg\,(m^2)}{s^2} \right) \quad \textbf{(3.1.10)}$$

Electron Energy (E_e)

$$r_e = K_e^2 \lambda_l g_\lambda = 2.8179 \cdot 10^{-15} \, (m) \tag{3.1.11}$$

Electron Classical Radius (r_e)

3.2. Photon Energy – Transverse Energy Equation

This section derives and explains the Transverse Wavelength Equation. 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. 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.

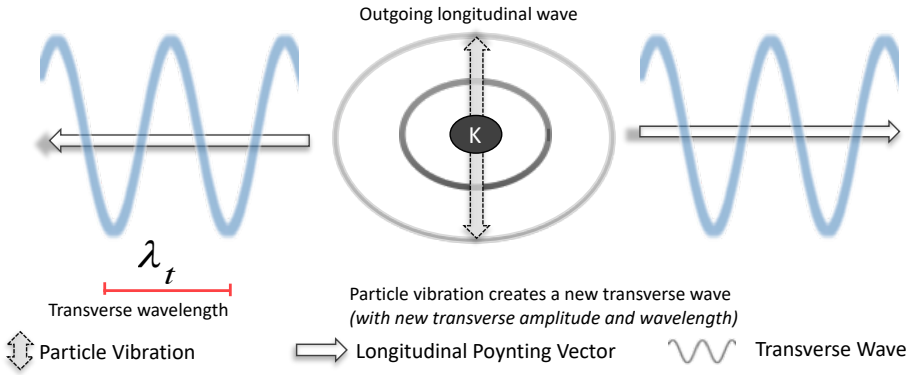


Fig 3.2.1 –Transverse Wave Created by Particle

It can also be illustrated in a three-dimensional view, as shown earlier in Fig. 3.2., showing the vibration of the particle and the transverse wave that is created perpendicular to particle vibration. Because the particle is continually reflecting longitudinal waves, it travels along with the transverse wave. Fig. 3.2 is the common view of the electromagnetic (EM) wave with its electric and magnetic components, which are transverse and longitudinal wave components within the photon.

As an electron moves closer or further from another particle, constructive wave interference changes, resulting in a change of longitudinal wave energy. Energy is always conserved, so a vibration that results from this change in longitudinal energy (E_l) is transferred to transverse energy (E_t). Since there are two waves that travel in opposite directions from the source of vibration (Fig. 3.2.2), one photon energy will be half of this longitudinal wave energy. This is expressed in Eq. 3.2.1.

$$E_t = \frac{1}{2}\Delta E_l \tag{3.2.1}$$

The change in longitudinal energy, shown in Eq. 3.2.2, is detailed in the *Forces* paper, where it will give rise to the electric forces between two particle groups of numerical count (Q). For example, one proton is Q=1. Two electrons is Q=2. The number of particles determines the constructive or destructive wave interference, over a distance (r). The electron energy (E_e) and radius (r_e) are from Eqs. 3.1.9 and 3.1.10 from the previous section.

$$\Delta E_l = E_e r_e \left(\frac{Q_1 Q_2}{r}\right) - E_e r_e \left(\frac{Q_1 Q_2}{r_0}\right) \tag{3.2.2}$$

For atoms, the constructive wave interference calculations become complicated beyond the 1s orbital, as there are electrons from different angles and distances to consider. Thus, a single variable is assigned to the replace the numerical count (Q) when used for photon calculations – the amplitude factor (δ). The calculations of amplitude factors for various atomic configurations is found in the *Atomic Orbitals* paper. This convenient variable is replaced in Eq. 3.2.2.

$$\delta = Q_1 Q_2 \tag{3.2.3}$$

$$\Delta E_l = E_e r_e \left(\frac{\delta}{r}\right) - E_e r_e \left(\frac{\delta}{r_0}\right) \tag{3.2.4}$$

Eq. 3.2.4 is now substituted into 3.2.1. Then, the constants for the electron energy (E_e) and radius (r_e) from Eqs. 3.1.9 and 3.1.10 are substituted and then simplified.

$$E_t = \frac{1}{2}\frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} K_e^2 \lambda_l g_\lambda \left(\frac{\delta}{r}\right) - \frac{1}{2}\frac{4\pi\rho K_e^5 A_l^6 c^2 O_e}{3\lambda_l^3} K_e^2 \lambda_l g_\lambda \left(\frac{\delta}{r_0}\right) \tag{3.2.5}$$

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta}{r} - \frac{\delta}{r_0} \right) \qquad (3.2.6)$$

Transverse Energy Equation

An illustration is provided to understand the initial (r_0) and final (r) starting positions of the electron in an orbital in Fig. 3.2.2. Also pictured in the figure is a difference in longitudinal wave amplitude as a result of constructive or destructive wave interference – the amplitude factor (δ). The photon's transverse wave is *not* pictured in this illustration.

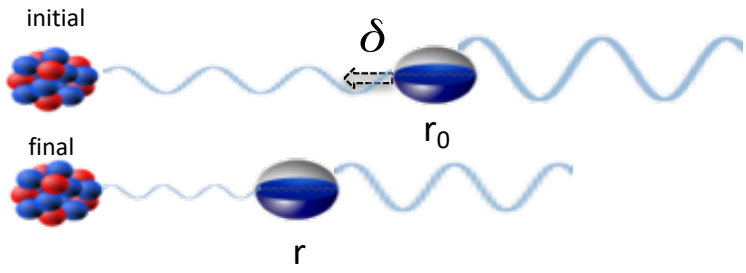


Fig 3.2.2 – Energy transition of electron

Hydrogen

Hydrogen is the simplest atomic element with one proton. In a stable configuration, hydrogen has one electron in the 1s orbital at a distance of the Bohr radius (a_0). Using the Transverse Energy Equation, the Rydberg unit of energy (R_y or E_{Ry}) is derived. The Planck constant will be derived in the next section after transverse wavelength and frequency are explained. The amplitude factor for hydrogen is one (δ_H=1).

$$E_{Ry} = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta_H}{a_0} - \frac{\delta_H}{\infty} \right) = 2.1799 \cdot 10^{-18} \left(\frac{kg\,(m^2)}{s^2} \right) \qquad (3.2.7)$$

Rydberg Unit of Energy

3.3. Photon Wavelength - Transverse Wavelength Equation

The photon has a variable wavelength and frequency, depending on the speed of vibration of the particle. In the Transverse Energy Equation, there are two variables that determine the energy of the photon. Since frequency is

proportional to energy, it has the same two variables: electron distance and wave amplitude factor. Thus, although frequency (f) appears to be one variable, it is in fact hiding two variables. Frequency is the number of cycles in a given timeframe, as illustrated in the next figure.

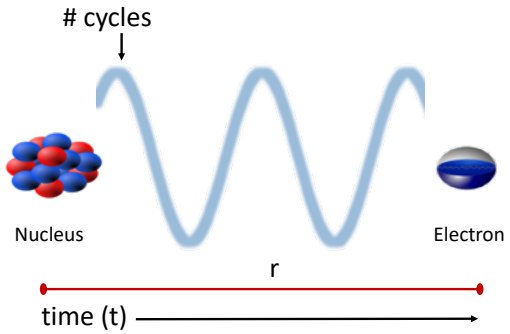


Fig 3.3.1 – Time, Cycles and Frequency

Because waves travel at the speed of light (c), time can be expressed in terms of distance and wave speed. Time is distance over velocity. To travel a distance (r) and back is 2r. At the speed of light, the time that it takes is:

$$t = \frac{2r}{c} \tag{3.3.1}$$

Frequency is the number of cycles over time:

$$f = \frac{n_{cycles}}{t} \tag{3.3.2}$$

It will be proven shortly that the number of cycles is based on constructive wave interference – the amplitude factor (δ). It goes through a change that is the fine structure constant (α_e) over 2π as the longitudinal wave transforms to a transverse wave.

$$n_{cycles} = \delta\frac{\alpha_e}{2\pi} \tag{3.3.3}$$

Substituting it into Eq. 3.3.3 and 3.3.1 into Eq. 3.3.2 and then simplifying yields:

$$f = \delta\frac{\alpha_e}{2\pi}\left(\frac{c}{2r}\right) \tag{3.3.4}$$

$$f = \delta\frac{\alpha_e c}{4\pi r} \tag{3.3.5}$$

The frequency equation can be tested for hydrogen, which has an amplitude factor of one. It matches the frequency for ground state hydrogen (1s) when the distance is the Bohr radius (a_0).

$$f_0 = \frac{\alpha_e c}{4\pi a_0} = 3.29x10^{15}\left(\frac{1}{s}\right) \tag{3.3.6}$$

Hydrogen (1s) Frequency

When the speed of light is removed from Eq. 3.3.6, it becomes the Rydberg constant, which has units of 1/m.

$$R_\infty = \frac{\alpha_e}{4\pi a_0} = 1.0974 \cdot 10^7\left(\frac{1}{m}\right) \tag{3.3.7}$$

Eq. 3.3.7 is expressed classically with the fine structure constant and the Bohr radius. But these constants can also be expressed in wave equation constants. From the *Fundamental Physical Constants* paper, they are the following.

$$\alpha_e = \frac{3\pi\lambda_l}{4K_e^4 A_l} \tag{3.3.8}$$

$$a_0 = \frac{1}{\lambda_l}\left(\frac{4K_e^5 A_l}{3\pi}\right)^2 g_\lambda \tag{3.3.9}$$

Substituting Eqs. 3.3.8 and 3.3.9 into Eq. 3.3.7 and then simplifying yields the same value and units of the Rydberg constant when expressed in wave constants.

$$R_\infty = \left(\frac{\pi\lambda_l}{2K_e^7}\right)^2\left(\frac{3}{4A_l}\right)^3 g_\lambda^{-1} = 1.0974 \cdot 10^7\left(\frac{1}{m}\right) \tag{3.3.10}$$

Rydberg Constant

The same conversion of the fine structure constant can be done for frequency. Eq. 3.3.8 is substituted into Eq. 3.3.5:

$$f = \frac{3\lambda_l c}{16K_e^4 A_l}\left(\frac{\delta}{r}\right) \tag{3.3.11}$$

But similar to the Transverse Energy Wave Equation, it must account for situations where the electron moves between orbitals, where there is an initial distance (r_0) and final distance (r).

$$f = \frac{3\lambda_l c}{16K_e^4 A_l}\left(\frac{\delta}{r} - \frac{\delta}{r_0}\right) \tag{3.3.12}$$

Wavelength and frequency are related by the following Eq. 3.3.13. Then, substituting Eq. 3.3.12 into 3.3.13 yields the Transverse Wavelength Equation.

$$\lambda = \frac{c}{f} \tag{3.3.13}$$

$$\lambda_t = \frac{16K_e^4 A_l}{3\lambda_l} \frac{1}{\left(\frac{\delta}{r} - \frac{\delta}{r_0}\right)} \tag{3.3.14}$$

Transverse Wavelength Equation

Compton Wavelength

In Section 2, the photon wavelengths of hydrogen were calculated using the Transverse Wavelength Equation. Here, it can also be used to calculate the Compton wavelength of a photon that is created after the annihilation of an electron and positron.

Annihilation is complete destructive wave interference. The wave centers remain, but the waves from the electron and positron are opposite phase and destructive. When placed at a position of half of the electron's classical radius, they are completely destructive and settle into position and remain until a gamma ray separates the particles in a process known as pair production. This distance (r) is half of the electron radius found in Eq. 3.1.10. The amplitude factor for a single electron and positron is one (δ=1).

$$\lambda_C = \frac{16K_e^4 A_l}{3\lambda_l} \frac{1}{\left(\frac{\delta_H}{\frac{r_e}{2}}\right)} \tag{3.3.15}$$

Simplifying the equation yields the Compton wavelength.

$$\lambda_C = \frac{8K_e^6 A_l}{3} g_\lambda = 2.4263 \cdot 10^{-12}\,(m) \tag{3.3.16}$$

Compton Wavelength

Planck Constant

The Planck constant (h) relates energy to frequency in the equation E=hf. It is a proportionality constant with units of kg*m^2/s, so it is a constant hiding many other constants. These constants are already included in the Transverse Energy Equation (Eq. 1.2.2), shown again:

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta}{r} - \frac{\delta}{r_0}\right) \tag{3.3.17}$$

The variables for both transverse energy and frequency are the same: amplitude factor and distance, which are isolated on the right in parentheses. But the Planck relationship is expressed with frequency as a variable, not amplitude factor and distance. Thus, frequency is divided to yield the constants in Eq. 3.3.17 that will remain as the Planck constant. Eq. 3.3.17 is divided by the constants in frequency, from Eq. 3.3.12 and then simplified. The remaining constants are the Planck constant in wave equation format.

$$\frac{E_t}{f} = \frac{\frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda}{\frac{3\lambda_l c}{16 K_e^4 A_l}} \left(\frac{\delta}{r} - \frac{\delta}{r_0}\right) \tag{3.3.18}$$

$$\frac{E_t}{f} = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda \left(\frac{\delta}{r} - \frac{\delta}{r_0}\right) \tag{3.3.19}$$

$$h = \frac{32\pi\rho K_e^{11} A_l^7 c O_e}{9\lambda_l^3} g_\lambda = 6.626 \cdot 10^{-31} \left(\frac{kg\,(m^2)}{s}\right) \tag{3.3.20}$$

Planck Constant

3.4. Amplitude Factor Equation – 1s Orbital Ionization (H to Ca)

The calculations in Section 2 use a special equation to calculate the amplitude factor for 1s orbitals for the first 20 elements from H to Ca. A pattern emerges when calculating the two variables required for transverse energy calculation – amplitude factor and distance – for the 1s orbital of the first twenty elements until electrons begin to fill the 3d subshell. An alternative method was then developed to calculate photon energies for these elements without requiring a need to determine the 1s orbital radius, instead fixing the distance to be the Bohr radius.

This **simplified method** is given the name Amplitude Factor Equation – 1s Orbital Ionization. It can be used for any element through calcium knowing the number of protons and electrons for the element. The method works for heavily ionized elements where only one or two electrons exist in the atom, or an atom with its full complement of

electrons but energized to 1s energy as found in photoelectron spectroscopy experiments. The method approximates photon energies for:

- **Ionization Energy of $1s^2$ Electron from a Neutral Element (Photoelectron Spectroscopy)** – Removal of the electron from a neutral element, 1s orbital ionization energy captured in photoelectron spectroscopy experiments.
- **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:

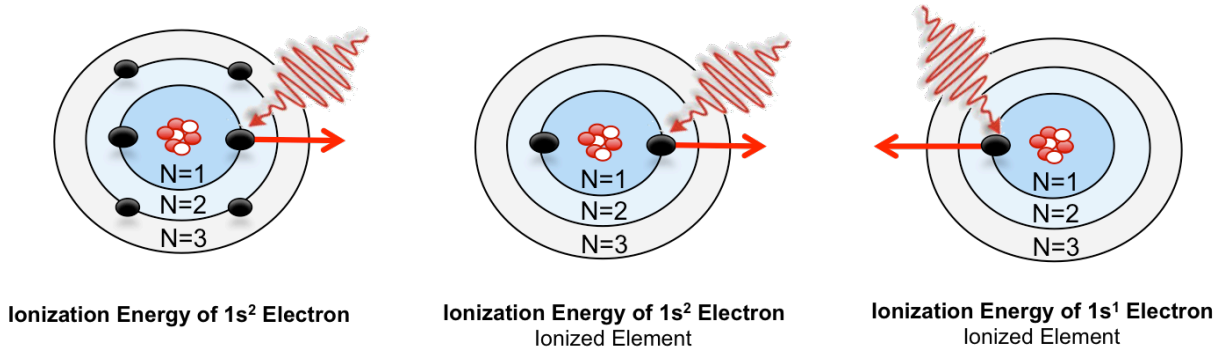


Fig. 3.4.1 – Electron Ionization and Amplitude Factors

The method works by setting the radius to the Bohr radius (a_0) then solving for a modified amplitude factor using Eq. 3.4.1. In the equation, Z is the number of protons in the atom, and e_1, e_2, e_3 and e_4 are the number of electrons in the first (1s), second (2s, 2p), third (3s, 3p) and fourth (4s, 4p) orbitals respectively.

$$\delta = \left((Z) - \frac{4}{3}\left(\frac{e_1 - 1}{2} + \frac{e_2}{8} + \frac{1}{2}\left(\frac{e_3}{8} \right) + \frac{1}{3}\left(\frac{e_4}{8} \right) \right) \right)^2 \qquad \textbf{(3.4.1)}$$

Amplitude Factor Equation – 1s Orbital Ionization

Results were calculated for hydrogen to calcium and placed in Section 1 and 2, although another example will be provided here to demonstrate the calculation using Eq. 3.4.1. Standard calcium (Ca) has 20 protons and 20 electrons. The amplitude factor for this configuration is:

$$\delta_{Ca} = \left(20 - \frac{4}{3}\left(\frac{(2-1)}{2} + \frac{8}{8} + \frac{1}{2}\left(\frac{8}{8} \right) + \frac{1}{3}\left(\frac{2}{8} \right) \right) \right)^2 = 296.605 \qquad \textbf{(3.4.2)}$$

This method uses a modified amplitude factor and Bohr radius (a_0) to calculate photon energy. Inserting these values into the Transverse Energy Equation:

$$E_t = \frac{2\pi\rho K_e^7 A_l^6 c^2 O_e}{3\lambda_l^2} g_\lambda \left(\frac{\delta_{Ca}}{\infty} - \frac{\delta_{Ca}}{a_0}\right)\left(\frac{N_A}{10^6}\right) = 389.4\left(\frac{MJ}{mol}\right) \qquad \textbf{(3.4.3)}$$

Eq. 3.4.3 calculates to be 389.4 MJ/mol. This is compared to a measured result of 390 MJ/mol. The remaining calculations are found in Section 1.

Why does it stop at calcium? In Fig. 3.4.1, 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.

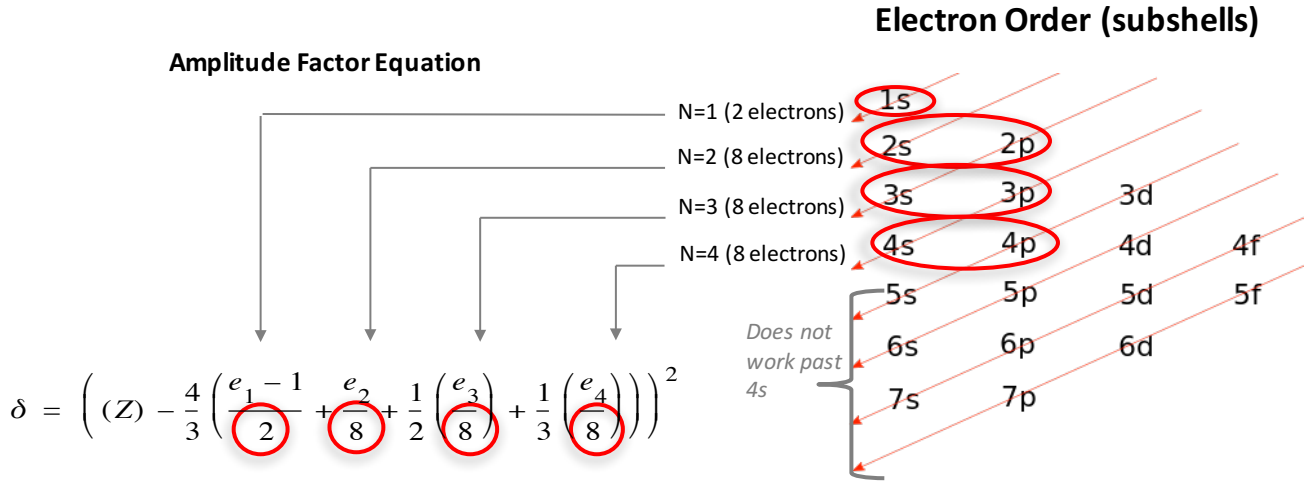


Fig 3.4.2 – Amplitude Factor Equation – 1s Orbital Ionization works for the first 20 atomic elements.

For the complete methodology of calculating amplitude factors for all atomic configurations, refer to the *Atomic Orbitals* paper.

4. 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.

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

- Calculated the energy and mass of particles, including the lepton family which coincides with magic numbers also seen in atomic elements.
- Calculated the wavelengths of photons from hydrogen, both ionization and transitions between orbitals.
- Calculated the photon ionization energies of the first twenty elements using the Transverse Energy Equation, using different configurations of electrons in each element to prove that wave amplitude and distance are the variables in the equation that governs transverse energy.
- Finally, the electron classical radius, electron Compton wavelength, Rydberg constant and Planck constant were naturally derived with wave constants proposed in this paper.

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. 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 (1.76×10^{-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 proton's core that is responsible for the attractive force. In high-energy proton collisions that break quark confinement, it is possible that positrons (and electrons) may be found in the quark-gluon plasma.
- This paper has calculated the photon ionization energies of the first twenty elements for only the 1s orbital. In the *Atomic Orbitals* paper, it is expanded to calculate the atomic radii and photon energies for all orbitals for hydrogen to calcium. However, further work needs to be done to calculate energies for atoms beyond calcium.

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