Explaining the Mass of Leptons with Wave Structure Matter

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Summary

The rest energy of leptons in the Standard Model has a strange sequence, increasing by orders of magnitude from ~2.2 eV for the lightest electron neutrino to 1.777 GeV for the sixth and largest lepton in the model, the tau electron.

This paper details an equation that identifies the sequence and calculation for the rest energy and mass of the six leptons in the Standard Model. Surprisingly, when identifying the sequence, the magic numbers that were found in the Periodic Table of Elements for the atomic structure are also apparent in the sequence for leptons. As a result, a new table structure for lepton categorization in the Standard Model is proposed in this paper.

The creation of an equation to predict the lepton sequence and energy was derived from a new, Wave Matter Energy equation that is also proposed in this paper. The genesis of this equation is based on principles from Wave Structure Matter (WSM), proposed by Dr. Milo Wolff. In WSM, Wolff suggests that the electron is a standing wave of energy. One of the issues of WSM, however, is that it does not have an explanation for other particles found in the Standard Model, including the neutrino and other leptons. Perhaps the most important of these missing particles is the neutrino. If there is a fundamental particle that is responsible for wave generation, and responsible for creating other particles found in the Standard Model, the likeliest candidate would be the smallest and lightest particle – the neutrino.

This research began with an assumption that the neutrino was the fundamental particle and that the electron, and other leptons, are built from neutrinos. Another key assumption is that leptons are spherical standing waves, and that the radius of the particle's sphere is proportional to the amplitude of the wave. A combination of these assumptions, along with the proposed Wave Matter Energy equation, led to the formula that identifies the sequence and energy of leptons.

Finally, there is one test that is offered to validate this theory. A new neutrino appears in the proposed sequence. Discovery of a neutrino at the predicted energy and mass could offer proof of the sequence and structure proposed for leptons in this paper.

The Wave Energy Equation

As Milo Wolff identified in his paper, "Beyond the Point Particle – A Wave Structure for the Electron", the electron is proposed to be a pair of spherical outward and inward quantum waves.[1] In the WSM model, the electron consists of standing waves of energy. It has a defined radius because standing waves eventually transition to traveling waves. The wave core is located at the center of the sphere. The energy of the particle can then be considered to be the total energy of the standing waves inside the sphere of the particle – for a particle at rest.

A particle emits and absorbs spherical, longitudinal waves. At rest, its inwaves and outwaves are equal in frequency. When in motion along any axis in one dimension, the frequency of its longitudinal inwaves and outwaves change, but it still maintains a standing wave structure. When in motion, the particle can create a secondary, transverse wave perpendicular to the axis of motion – particularly vibrating particles. These longitudinal waves and transverse waves become the heart of the Wave Energy Equation.

At rest, there is no motion, thus only the longitudinal wave needs to be considered to describe its energy. This equation is:

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

Wave Energy Equation – Particle at Rest

p = density of wave medium
V = Volume
f_l = longitudinal frequency
A_l = longitudinal amplitude

Note that the equation refers to the density of a wave medium, which is sometimes referred to as the aether. It is not the intention of this paper to debate the existence or non-existence of the aether. However, the density variable is required to balance the equation in SI units.

Deriving the Mass of Leptons

A Lepton Mass Ratio equation was created to determine the mass of leptons, from the well-known properties of the electron. The objective was to find a formula that predicts and explains the sequence for all of the leptons in the Standard Model.

To create this ratio equation, the following assumptions were used:

1. All leptons have the same longitudinal wave frequency
2. The electron is not a fundamental particle and consists of an unknown (w_e) number of particles. These particles, assumed to be the neutrino, generate waves that constructively add to the longitudinal amplitude of the electron.

3. Neutrinos are placed at a multiple of a wavelength (perhaps only one wavelength) from each other, such that they reside on the node of a wave. Thus, their waves constructively add in integers, hereafter referred to as wave count. The amplitude of a particle depends on the wave count (w_x) of the neutrinos that form the particle.

4. Leptons have a radius that is proportional to longitudinal amplitude. Inside this radius are spherical, longitudinal standing waves that are measured as mass. Outside the radius (spherical shell), the waves convert to traveling waves.

At rest, the energy difference between leptons is based on amplitude, formed from constructive wave addition. The amplitude also changes the radius (volume) of the lepton, thus the energy change is the following:

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

Since it was assumed that the neutrino is the fundamental particle, but the mass of the electron is better established, the electron was used as a reference point. Two variables were introduced to the equation to establish a ratio, first between the electron and the baseline particle (neutrino), and then from the neutrino to other particles. These variables are:

w_x = Wave count of particle being calculated

w_e = Wave count of electron

Due to its length, the derivation of the Lepton Energy Ratio equation, from the Wave Energy Equation, can be found in Appendix 1. The result is:

$$E_x = E_e \left(\frac{w_x}{w_e} \right)^5$$

Lepton Energy Ratio Equation

Where:

E_x = Energy of particle being calculated

E_e = Energy of electron

Because the wave count of the electron (w_e) was unknown, different values were attempted to find a baseline that matched the properties of the neutrino. At $w_e = 10$, which is a tetrahedral number, the ratio between the neutrino and electron are within range, but not perfect. Using the established Particle Data Group (PDG) energy of the electron (0.000511 GeV), and assuming the neutrino has a wave count $w_x = 1$, the calculated energy is 5.11E-9 GeV. Although the neutrino's rest energy is not known, it is compared with a rest energy on the high-end of predicted models - 2.2 eV (2.2E-9 GeV). The calculation is off by more than a factor of 2 for the largest predicted neutrino energy, however, the remaining leptons are within range, surprisingly at wave counts that match the magic numbers in the Periodic Table.

The calculated particle energies, using an electron wave count of 10 ($w_e = 10$), compared with the accepted PDG energies of leptons are provided in Table 1 on rows two and three respectively.[2] The difference between the two values is provided on row four.

An example calculation for wave count 8 ($w_x = 8$), is $E_8 = 0.000511$ GeV * $(8/10)^5 = 0.000167$ GeV which falls within range of the muon neutrino.

	Electron	Neutrino	Neutrino X	Muon Nuetrino	Tau Neutrino	Muon Electron	Tau Electron
Wave Count	10	1	2	8	20	29	51
Calculated Energy (GeV)	0.000511	5.11E-09	1.64E-07	1.67E-04	0.0164	0.1048	1.763
PDG Energy (GeV)	0.000511	2.2E-09	N/A	1.70E-04	0.0155	0.1057	1.777
Difference (%)	0.00%	-132.27%	N/A	1.50%	-5.50%	0.84%	0.78%

Table 1 – Calculated Mass of Leptons

Observations about the calculations:

- Leptons were assumed to be standing waves, of equal amplitude inwaves and outwaves. However, if the single wave neutrino is considered as an outwave or an inwave only (i.e. a source or a sink), then it would have half the energy calculated. The correction would be 5.11 eV / 2 = 2.55 eV. This is much closer to the PDG value of 2.2 eV.

- The remainder of the leptons fall within a percentage difference, except for the tau neutrino (5.5% difference). One possibility is the actual measurements of these particles may be incorrect. However, a more likely possibility is the geometric alignment of neutrinos such that they do not always constructively add their waves in integers. In the *Proposed Geometric Structure of Leptons* section, a tetrahedron structure is proposed that could lead to slight differences. It's worth a reminder that the atomic weights in the Periodic Table of Elements are not exact integers either.

- The first five magic numbers in the Periodic Table are 2, 8, 20, 28 and 50. Interestingly, these magic numbers are also seen here in the Lepton Sequence, although the muon electron and tau electron exceed by one wave count (29 and 51 respectively), to not match the magic numbers perfectly. A revision of Table 1 is provided in Appendix 2 with the values matching all of the magic numbers perfectly, however, there is a much larger difference between the PDG energy value and the calculated value using the Lepton Energy Ratio equation.

- Only leptons were considered as quarks and other particles have very different characteristics. However, it's worth noting that at $w_x = 45$, a mass of 0.943 (GeV) is calculated, very close to the mass of the proton (0.9382 GeV).[3]

Proposed Table for Lepton Structure

The similarity between the magic number sequence in the Periodic Table and the wave count in the Lepton Sequence leads to the possibility that both share a similar geometric structure when their subcomponents form a complete structure: the atom's nucleus formation from protons and neutrons, and the lepton particle's formation from neutrino and antineutrino waves.

A new table structure is proposed for the leptons in the Standard Model, matching its characteristics to a geometric structure based on tetrahedron formation and stacking. Whereas the Periodic Table is categorized based on proton number, the Lepton Sequence is categorized based on wave count number. The proposed categorization is found in Figure 1.

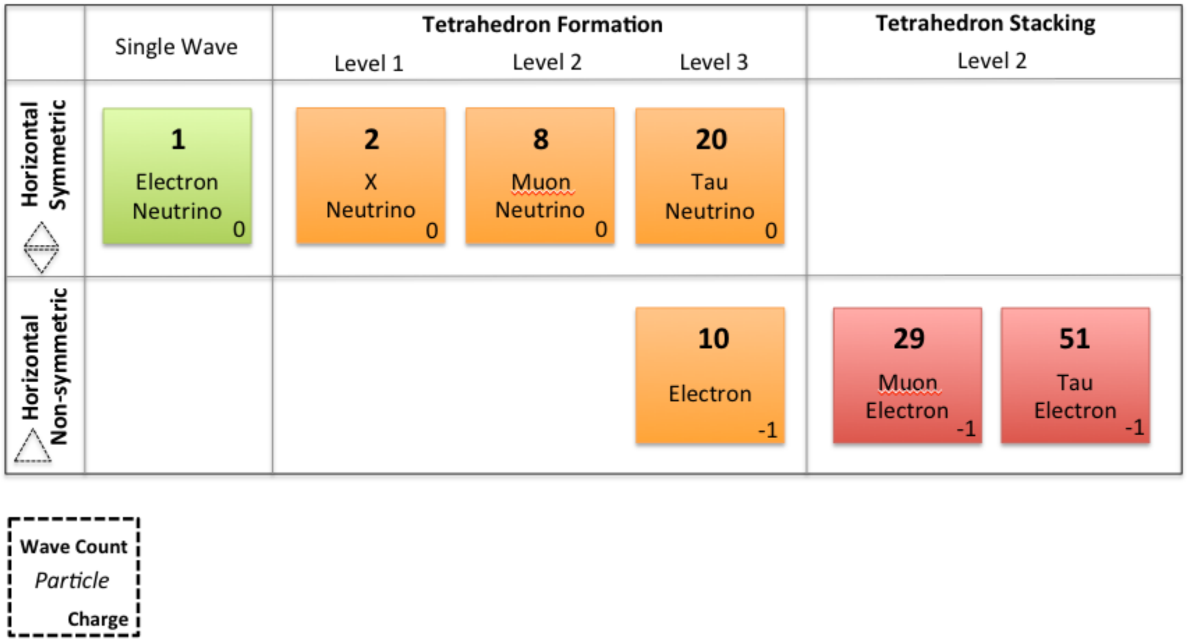


Figure 1 – Categorization of Lepton Sequence

Notes about the proposed table structure:

- Wave count was used as terminology instead of "neutrinos". Waves can be constructive or destructive and thus the actual neutrino count may be different than the wave count.
- The anti-particles of each lepton are assumed to be formed from anti-neutrinos of the same wave count.
- The neutrino, and its antiparticle, are assumed to be the particle responsible for constructive and destructive waves. They would have wave count 1 and -1.
- Wave count numbers 2, 8 and 20 have horizontal symmetry at the first three tetrahedron levels (1+1, 4+4, 10+10). These leptons have no charge.
- Assuming the magic number sequence from the Periodic Table is replicated in the Lepton Sequence, wave count 2 would be a new neutrino, labeled Neutrino X. Its calculated energy is 164 eV, perhaps small enough that it is thought to be the electron neutrino in experiments. Discovery of a neutrino at this energy could validate this Lepton Sequence.
- The electron, at wave count 10, is not in the magic number sequence. However, it is a 3-level tetrahedron. It does not have horizontal symmetry.
- At wave counts 29 and 51, the muon electron and tau electron are neither tetrahedral numbers nor two tetrahedrons stacked with horizontal symmetry. It is proposed that these particles are formed by smaller tetrahedrons in a stacking formation, attempting to form a "larger" tetrahedron. A possible formation is proposed in the next section.

Proposed Geometric Formation Structure of Leptons

This section intends to describe the structural formation of leptons such that it matches a lepton's characteristics of mass, spin and charge. The possible structural arrangements to get to the wave counts found in the Lepton Sequence are numerous. The formations suggested in this paper are theoretical and one of a number of possibilities. Further work in this area could model various formations, perhaps with computer simulations, to validate the electromagnetic cohesion of these or alternative structures.

One of the aforementioned assumptions is that neutrinos are placed at a multiple of a wavelength (perhaps only one wavelength) from its closest neighbor. This puts a particle at the node of the wave. There are two nodes in each wavelength of a sine wave: one positive and one negative. These were assumed to be the neutrino and anti-neutrino as described in Figure 2.

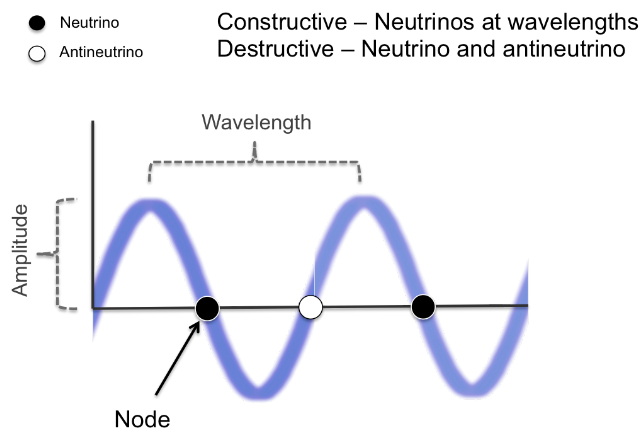


Figure 2 – Neutrino and Antineutrino Placement

Placed at a wavelength (or multiple of a wavelength) apart, the neutrino waves would be constructive in phase; two neutrinos in close proximity would have double the amplitude. Further, neutrinos not at the node, would attempt to position the particle center on the node, causing movement of the particle. This assumption leads to the tetrahedron as the suitable candidate for a geometric structure as neutrinos can be placed at the necessary space (wavelengths) between its nearest neighbors. A tetrahedral structure would not be surprising, given that it is also seen in molecule formation as well.

The waves follow Huygens' principle and can be thought of as wavelets being generated from each and every particle forming a wavefront. It was further assumed that each particle operates at the same frequency.

At the opposite node from the neutrino is the antineutrino. It was assumed that the presence of an antineutrino leads to destructive wave interference. For the purposes of geometric modeling, a value of +1 was assigned to the neutrino, and a value of -1 was assigned to the antineutrino. For example, a neutrino and antineutrino in close proximity would have a wave count 0 (1-1=0). Or 10 antineutrinos would have a wave count -10 (the anti-particle to the electron – the positron). Or, an electron and positron in close proximity wouldn't annihilate, but rather would have a wave count 0 (10-10=0) such that it could not be detected with electromagnetic instruments. It would still be a particle until sufficient energy was provided to separate the particles.

The above assumptions were used to generate a potential structure for each lepton.

<u>Neutrino X</u>

Wave count 2 is a magic number and thus included in the lepton formation, even though it is not an identified particle. Its formation is likely only two neutrinos in a formation such as the following in Figure 3.

Total Particles	2
Constructive Waves	2
Destructive Waves	0
Wave Count	**2**
Horizontal Symmetry	Yes

Figure 3 – Potential Structure of Neutrino X

<u>Muon Neutrino</u>

Wave count 4 may be explained by two 2-level tetrahedrons stacked in the formation shown in Figure 4. This formation has horizontal symmetry.

Total Particles	8
Constructive Waves	8
Destructive Waves	0
Wave Count	**8**
Horizontal Symmetry	Yes

Figure 4 – Potential Structure of Muon Neutrino

<u>Electron</u>

Wave count 10 can be explained by a 3-level tetrahedron. Assuming this is a stable geometric shape, the electron can be used to form other, larger structures. Unlike the previous particles found at lower wave counts, the electron and its antiparticle have a charge. The electron does not have horizontal symmetry.

Total Particles	10
Constructive Waves	10
Destructive Waves	0

Wave Count	**10**
Horizontal Symmetry	No

Figure 5 – Potential Structure of Electron

Tau Neutrino

Wave count 20, like the muon neutrino, may be explained by two tetrahedrons stacking symmetrically again – this time a 3-level tetrahedron. It's worth noting that the shape in Figure 6 consists of two electrons stacked symmetrically on the horizontal axis; worth mentioning given that electrons are known to repel each other. 20 is also a tetrahedral number and it is possible this shape is a 4-level tetrahedron, but it wouldn't have horizontal symmetry and would be inconsistent in terms of charge (other neutrinos with horizontal symmetry have no charge).

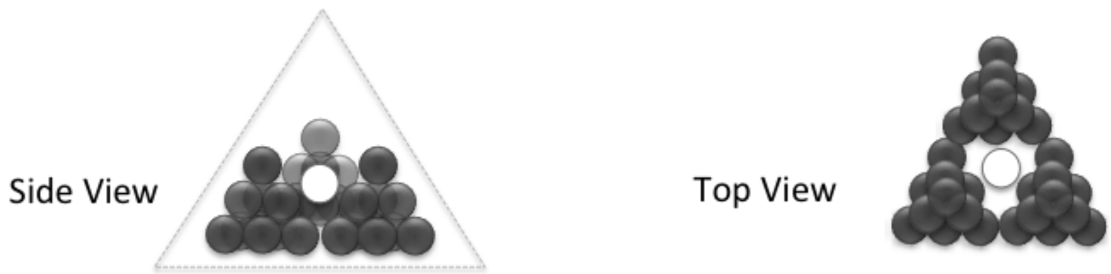
Total Particles	**20**
Constructive Waves	20
Destructive Waves	0
Wave Count	**20**
Horizontal Symmetry	Yes

Figure 6 – Potential Structure of Muon Neutrino

Muon Electron

Wave count 29 becomes more difficult to predict, as there are more variations as the count increases. One potential explanation is that the stable 3-level tetrahedron particle (the electron) begins a stacking process, creating larger tetrahedrons. Figure 7 is purely theoretical, but offers one potential way to stack tetrahedrons. Three electrons forming the base of a new, larger but incomplete tetrahedron would consist of 30 particles and thus wave count 30. However, it might be unstable and require an antineutrino at its center to attract the electrons and keep them in formation. Although there would be 31 total "neutrino" particles, it would be wave count 29 (30-1=29; 30 neutrinos - 1 antineutrino).

The challenge with this explanation is that it does not match the observations of the muon electron decay, which decays to an electron, an antineutrino and a muon neutrino (which are wave counts 10, -1 and 8) in the Lepton Sequence.[4] This explanation would be accurate if the decay was an electron, antineutrino and tau neutrino (wave counts 10, -1 and 20 = 29). The tau neutrino in this model is two electrons stacked horizontally with symmetry. A third electron added could create the base of a new tetrahedron.



Total Particles	**31**
Constructive Waves	30
Destructive Waves	1
Wave Count	**29**
Horizontal Symmetry	No

Figure 7 – Potential Structure of Muon Electron

Tau Electron

Wave count 51 is also challenging because of the many possible variations. If the muon electron stacking formation is used as a base, then it is possible that the tau electron is the completion of the larger tetrahedron that began as the muon, formed in the stacking process. The muon electron proposed particle count is 31, and thus by adding a tau neutrino (wave count 20) to the muon electron, it would have a particle count of 51. It would also have a tetrahedral structure as shown in Figure 8. However, the presence of the antineutrino (from the muon electron) would give the tau electron a wave count of 49, not 51 in the model. One possibility is that the antineutrino is forced into a geometric position that is a half wavelength from its original position on the wave (the opposite node), now causing it to add constructively instead of being destructive. Of course, this is purely theoretical.

Like the muon electron, this proposed formation does not match the decay modes for the tau electron. One of the possible ways a tau electron decays, 17.39% of the time, is into: a tau neutrino, a muon electron and a muon antineutrino.[5] The tau neutrino and muon electron can be explained, but not the muon antineutrino – although it would be correct if it were an antineutrino. But this proposed formation offers no explanation for the other tau decay modes.

Total Particles	**51**
Constructive Waves	51
Destructive Waves	0
Wave Count	**51**
Horizontal Symmetry	No

Figure 8 – Potential Structure of Tau Electron

Potential explanations for lepton characteristics when considering tetrahedral structures:

- Charge – A single tetrahedron does not have horizontal symmetry. Consider the side view of the electron in Figure 5. The base will have more neutrinos than the top when split on a horizontal axis. If each neutrino in the formation is sending constructive waves, there will be a slight irregularity in the sphere, shorter in the vertical axis in the top direction, longer in the base direction. The particle formations with horizontal symmetry (wave counts 2, 8 and 20) do not have this irregularity.

- Spin – Leptons have an interesting spin of ½, which requires a 720 degree rotation to bring the lepton back to its original state.[6] Although this paper does not offer an explanation of how a lepton spins, it is worth noting that a tetrahedron has 12 rotational symmetries and can be placed in one of 12 distinct positions when rotating.[7]

- Wave Amplitude – The tetrahedron structure allows neutrinos to be in phase with their closest neighbors. When this happens, waves constructively add in integers. But some neutrinos in the structure will be slightly out of phase with others. For example, in the proposed structure of the tau neutrino in Figure 6, a neutrino at level 1 in the top tetrahedron is not in phase with a neutrino in the vertex at level 3 in the bottom tetrahedron. In these cases, wave construction may not be at perfect integers.

The geometric structures offered in this section are theoretical as a possible explanation for the wave counts found for the Lepton Sequence. Alternative structures should also be considered, particularly ones that may explain the decay of the muon and tau electrons.

Conclusion

The method used to derive the Lepton Energy Ratio in this paper started with an assumption that the electron was not a fundamental particle, and was instead created from a baseline particle assumed to be the neutrino. Two variables were added to form the ratio: 1) the electron wave count, and 2) a calculated lepton wave count. A combination of these two variables could lead to thousands of variations, increasing the chances of finding a match of the Lepton Sequence. However, considering that the lepton range from the smallest to the largest is on the order of 10^9, it is comparable to playing a lottery to hit five numbers, each ranging from one to a billion (although the numbers were not a perfect match and varied in most cases by a percentage point). Nevertheless, it is possible that it is merely a coincidence, thus additional information was provided to support the finding.

First, a structure is proposed to explain the sequence in which the wave counts appear. The fact that the numbers match the magic numbers found in the Periodic Table is interesting, but not proof itself. But it leads to potential research to explain the relation between particle formation and atomic element formation, if they share the same geometric structure. A tetrahedral structure was proposed in the Categorization of Lepton Sequence in this paper.

Second, a potential geometric model of each of the leptons was proposed to match the wave counts and Lepton Sequence. Again, tetrahedral structures were assumed, and organized into geometric shapes that are likely stable and match the characteristics seen in leptons for charge and spin. This work is purely theoretical and offered as one potential explanation, although many other geometric formations are also possible to match the wave counts found and should be considered as well. Further research in this area could be computer modeling and simulation of various geometric structures for each of the leptons. In particular, resolving the decay methods of the muon electron and tau electron that cannot be explained by the proposed geometric structures in this paper.

Lastly, a new Wave Energy Equation was introduced, which was used to derive the Lepton Energy Ratio equation. The ratio equation was not chosen randomly and coincidentally hit the lepton sequence, but instead was derived from the Wave Energy Equation. An explanation of the equation was provided since it is fundamentally different from well-established energy equations.

These findings suggest that the neutrino may be the fundamental particle and that matter is formed from standing waves of energy.

Appendix 1

Deriving the Lepton Energy Ratio Equation

The following is the derivation of the Lepton Energy Ratio Equation.

$E = \boldsymbol{\rho} V (f_l A_l)^2$	1) Begin by solving for the baseline particle – assuming the electron as a reference point – using the simplified version of the Wave Energy Equation for a particle at rest
$E = \boldsymbol{\rho} V \left(\frac{c}{\lambda_l} A_l \right)^2$	2) Expand frequency, as wavelength is known for the electron – Compton wavelength
$A_l \sqrt{\boldsymbol{\rho}} = \frac{\lambda_l \sqrt{E}}{c \sqrt{V}}$	3) Isolate the unknown terms on the left side of the equation. Everything on the right is known for the electron (Compton wavelength, energy and volume).
$x = A_l \sqrt{\boldsymbol{\rho}}$	4) For readability purposes, assigning a temporary variable (x) to the unknown terms. This is the amplitude-density of the electron.
$A_0 \sqrt{\boldsymbol{\rho}} = \frac{x}{w_e}$	5) The amplitude-density of the baseline particle (A_0) is the amplitude-density of the electron (x) divided by an unknown number of particles / wave count (w_e). The variable w_e will be used to determine how many particles/waves are in an electron.
$A_x \sqrt{\boldsymbol{\rho}} = A_0 \sqrt{\boldsymbol{\rho}} \cdot w_x$	6) Once the baseline particle amplitude-density is known, then any particle amplitude-density can be found (A_x). Assuming waves are constructive in integers, the variable w_x is assigned to determine the wave count of the new particle.
$A_x = A_0 w_x$	7) Density cancels, so the amplitude of the new particle (A_x) is simply the baseline particle amplitude multiplied by the wave count w_x. There is now a relation established between the electron's amplitude, to the baseline particle's amplitude, to any particle that has constructively added its waves by a multiple of w_x.
$\Delta r \propto \Delta A$	8) The radius, and thus volume, of each particle is also unknown. A similar approach is used to find a baseline for radius. But first, an assumption that the radius is proportional to amplitude. A larger amplitude results in a larger radius before the standing waves break down to traveling waves.
$r_0 = \frac{r_e}{w_e}$	9) Similar to the approach for amplitude, a baseline particle's radius is determined by dividing the radius of the electron by the unknown particles that make up the electron (w_e).
$r_x = r_0 w_x$	10) The new radius, of any particle being determined, is a multiple of the wave count (w_x), because it is assumed amplitude and radius are proportional.
$E = \boldsymbol{\rho} V (f_l A_l)^2$	11) Now that a relation between the unknown variables for amplitude and radius have been made to the electron and baseline particle, it can be used to find the energy of a new particle using the Wave Energy Formula.
$E_x = \boldsymbol{\rho} \frac{4}{3} \pi (r_x)^3 f^2 (A_x)^2$	12) Solve the new particle's energy (E_x), with new radius (r_x) and new amplitude (A_x).

$$E_x = \boldsymbol{\rho}\frac{4}{3}\pi\left(r_e\frac{w_x}{w_e}\right)^3 f^2\left(x^2\frac{w_x^2}{w_e^2\boldsymbol{\rho}}\right)$$	13) Substitute and simplify the values r_x and A_x using the equations determined above.
$$E_x = \frac{4}{3}\pi\left(r_e\frac{w_x}{w_e}\right)^3 f^2\left(x^2\frac{w_x^2}{w_e^2}\right)$$	14) Density cancels out.
$$E_x = \frac{4}{3}\pi\left(r_e\frac{w_x}{w_e}\right)^3 f^2\left(\frac{\lambda_l^2 E_e}{c^2 V}\frac{w_x^2}{w_e^2}\right)$$	15) Substitute back in for the temporary variable x (placeholder for readability until now)
$$E_x = \frac{4}{3}\pi\left(r_e\frac{w_x}{w_e}\right)^3 f^2\left(\frac{\lambda_l^2 E_e}{c^2\frac{4}{3}\pi r_e^3}\frac{w_x^2}{w_e^2}\right)$$	16) And then expand volume (V) which is the spherical volume for the electron
$$E_x = \left(\frac{w_x}{w_e}\right)^3 f^2\left(\frac{\lambda_l^2 E_e}{c^2}\frac{w_x^2}{w_e^2}\right)$$	17) Cancel variables
$$f = \frac{c}{\lambda_l}$$	18) Frequency remains in 17, but the frequency of the new particle is the same as the electron.
$$E_x = E_e\left(\frac{w_x}{w_e}\right)^5$$	19) Substitute frequency back into the equation in 17, cancel the variables and the lepton mass ratio appears. E_x – Energy of calculated particle E_e – Energy of electron w_x – Wave count - calculated particle w_e – Wave count - electron

Appendix 2

Alternative Table for Leptons Using True Magic Numbers

In Table 1, the values for the muon electron and tau electron had wave counts of 29 and 51 respectively, just missing the magic number sequence by one (28 and 50). The following table shows the calculated mass of the muon and tau if the true magic numbers are used. The mass calculation differs from the PDG mass by 16.80% and 10.14% respectively.

	Electron	**Neutrino**	**Neutrino X**	**Muon Nuetrino**	**Tau Neutrino**	**Muon Electron**	**Tau Electron**
Wave Count	10	1	2	8	20	28	50
Calculated Energy (GeV)	5.11E-04	5.11E-09	1.64E-07	1.67E-04	0.0164	0.0879	1.597
PDG Energy (GeV)	0.000511	2.2E-09	N/A	1.70E-04	0.0155	0.1057	1.777
Difference (%)	0.00%	-132.27%	N/A	1.50%	-5.50%	**16.80%**	**10.14%**

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