The Periodic Table of Subatomic Particles

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Summary

Until the 1800s, elements such as gold, silver and copper were thought to be fundamental materials that shared no common building blocks. The world, at that time, was believed to be composed of various different elements. By 1869, when Dmitri Mendeleev published a paper categorizing these elements into a table, 63 elements had been discovered. Mendeleev, and other chemists during his era, began to recognize patterns in the table. These patterns would eventually predict and lead to the discovery of many more elements, organized into the Periodic Table of Elements that we use today.

By the early 1900s, the proton was discovered, partially explaining why elements fit into the sequence in the Periodic Table of Elements. For the past century, the scientific community has recognized that elements are formed from atoms that differ based on the number of protons in the atom's nucleus. Hydrogen has one proton, helium has two protons, and ununoctium, the last element in the table, has 118 protons. There are more than one hundred elements, yet nature's simplicity forms these unique elements based on the number of protons in the core of the atom.

In the 1900s and into present day 21st century, the search continues, but now for particles that make up the atom itself. Protons are not fundamental particles, as they can be smashed together in particle accelerators to find smaller parts that construct the proton. These collisions also happen naturally as cosmic rays from the universe bombard Earth's atmosphere and create a shower of subatomic particles. However, this search has yielded dozens of particles and many more are still being discovered. Atomic elements were eventually simplified to be nothing more than a configuration of protons, yet the world smaller than the proton appears to be an array of unique particles of mass, spin, charge and color (terms used to describe these particles). Is it possible that history will repeat itself and that the scientific community will find that there is one common building block to each of the subatomic particles?

This paper provides evidence that a fundamental particle exists, forming the basis of subatomic particles that have been discovered to date, in a similar way that the proton simplified the understanding of elements. The fundamental particle is the lightest of subatomic particles found – the neutrino. Particles, including the electron, proton, neutron and countless others may be formed from various configurations of the neutrino.

For comparison, the known particles have been grouped into a periodic table, similar to the work Mendeleev performed with the original Periodic Table of Elements, to show similarities between particles and atomic elements. This paper describes the Periodic Table of Particles, how it was formed, and how it can be used to predict and organize subatomic particles.

Background

In *Particle Energy and Interaction: Explained and Derived by Wave Equations*, an energy equation was proposed to calculate the mass of particles based on the number of neutrinos in the particle's core.[1] The concept is simple because it is based on a similar model of the atom and the construction of the nucleus. Nature repeats itself. Neutrinos, and their counterpart antineutrinos, combine in geometric formations to form particles such as Figure 1.

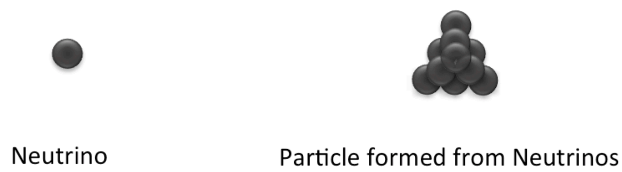


Fig. 1 – Particle Formation

Neutrinos, in this model, are not objects. They are wave centers of energy. They are the center point where spherical, longitudinal waves are emitted and absorbed. This forms a standing wave at the core, but beyond the perimeters of the particle, waves transition from standing waves to traveling waves. A particle's mass is measured as the sum of its standing wave of energy, so as neutrinos combine to form particles, their standing waves constructively add, considerably increasing the energy of the standing waves with each incremental neutrino.

Neutrinos must be at the node of the wave, or the antinode of the wave in the case of antineutrinos, to be stable. Otherwise, it will be forced into motion. This causes certain geometric particle formations to be stable, whereas other arrangements will decay quickly. Figure 2 shows an example of the energy wave and placement of neutrinos.

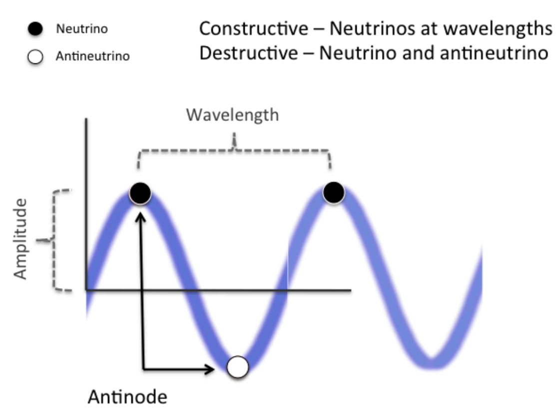


Figure 2 – Neutrino and Antineutrino Placement

Two neutrinos constructively add their waves, but a neutrino and an antineutrino create destructive wave interference. As an example, in particle annihilation, the electron and its antiparticle, the positron, are thought to disappear after annihilation. However, their waves are destructive to the point where there is no standing wave to be measured as mass. The particles are still there, with no measured mass, until a gamma ray with sufficient energy arrives to separate the particles, which is observed today as the mysterious pair production.[2]

The details of this model and its equations were proposed in an earlier paper, and only summarized here, so readers are encouraged to read *Particle Energy and Interaction* for more details. In that paper, a Longitudinal Energy Equation was derived based on an assumption that neutrinos formed the core of a particle and their standing waves constructively add to create a particle's energy. The Longitudinal Energy Equation is based on a familiar looking energy equation, re-written for wave energy.

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

When expanded for spherical, longitudinal wave energy, it has the form:

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

Longitudinal Energy Equation

Where:

E = Energy
ρ = Density = 9.422329851 x 10^{-30} (kg/m^3)
λ_l = longitudinal wavelength = 2.817940327 x 10^{-17} (m)
A_l = longitudinal amplitude = 3.662799228 x 10^{-10} (m)
V = Volume
c = speed of light
f_l = longitudinal frequency
K = wave center count (neutrinos)
n = shell number

Or, in visual format, the components of the Longitudinal Energy Equation can be seen Figure 3. It assumes that neutrinos are placed at wavelengths, their waves constructively add, and further that the radius of the particle where waves transition from standing waves to traveling waves increases proportionally with the amplitude of the standing wave generated from the combination of neutrinos.

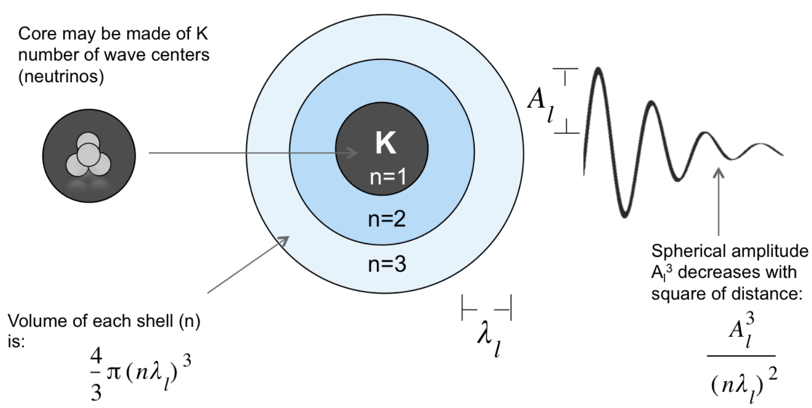


Fig. 3 – Derivation of Longitudinal Energy Equation

An example using the Longitudinal Energy Equation is shown below. Density (**ρ**), Amplitude (A) and Wavelength (**λ**) are constants found in the definitions above. In the equation, only Neutrino count (K) and Shell number (n) are variables. When measuring the total mass of a particle its shell number matches the total number of neutrinos as it accounts for all of the shells in the particle. In other words, n=K.

Therefore, Eq. 1.1 is an example particle with 10 neutrinos at the core (K). It is given a notation of $K_e = 10$ for the electron since the value matches the electron.

$$E_e = E_{l(10)} = \frac{4\pi \boldsymbol{\rho} K_e^5 A_l^6 c^2}{3\lambda_l^3} \sum_{n=1}^{K_e} \frac{n^3 - (n-1)^3}{n^4} \quad \textbf{(1.1)}$$

In Eq 1.2, the values of K and n are inserted into the equation, in addition to the constants for density, amplitude and wavelength.

$$E_e = \frac{4\pi (9.42208\cdot 10^{-30})\ (10^5)\ (3.66282\times 10^{-10})^6\ (2.99792\times 10^8)^2}{3\,(2.81794\cdot 10^{-17})^3}\ (2.13874) \quad \textbf{(1.2)}$$

In Eq 1.3 below, the equation is solved. The result is measured in Joules. For a particle with K=10 neutrinos, the mass is equal to the known property of the electron. Therefore, the electron, using the Longitudinal Energy Equation, consists of ten neutrinos.

$$E_{l(10,10)} = 8.18\cdot 10^{-14} \quad \textbf{(1.3)}$$

Again, the details of the use and complete derivation of the Longitudinal Wave Energy Equation, including its constants and example calculations, are left to the previous paper, *Particle Energy and Interaction*. A summary is provided in this section as a background since this equation is the core of the Periodic Table of Particles, which is organized based on neutrino count.

Periodic Table of Particles

The Longitudinal Energy Equation was used to calculate the rest mass of a formation of particles composed of neutrinos, from a single neutrino to a particle consisting of 118 neutrinos in its core. This was chosen to match the Periodic Table of Elements, although there is no evidence that there cannot be a formation larger than 118 neutrinos at the core. In atomic elements, the nucleus consists of protons and neutrons. The largest element in the Periodic Table of Elements includes 118 protons, yet one of the isotopes ^{294}Uuo, has an atomic weight of 294, giving it 176 neutrons. In a similar configuration in the subatomic particle world, this could mean up to 294, or more, configurations of neutrinos in the core, greatly exceeding the current limits of the Periodic Table of

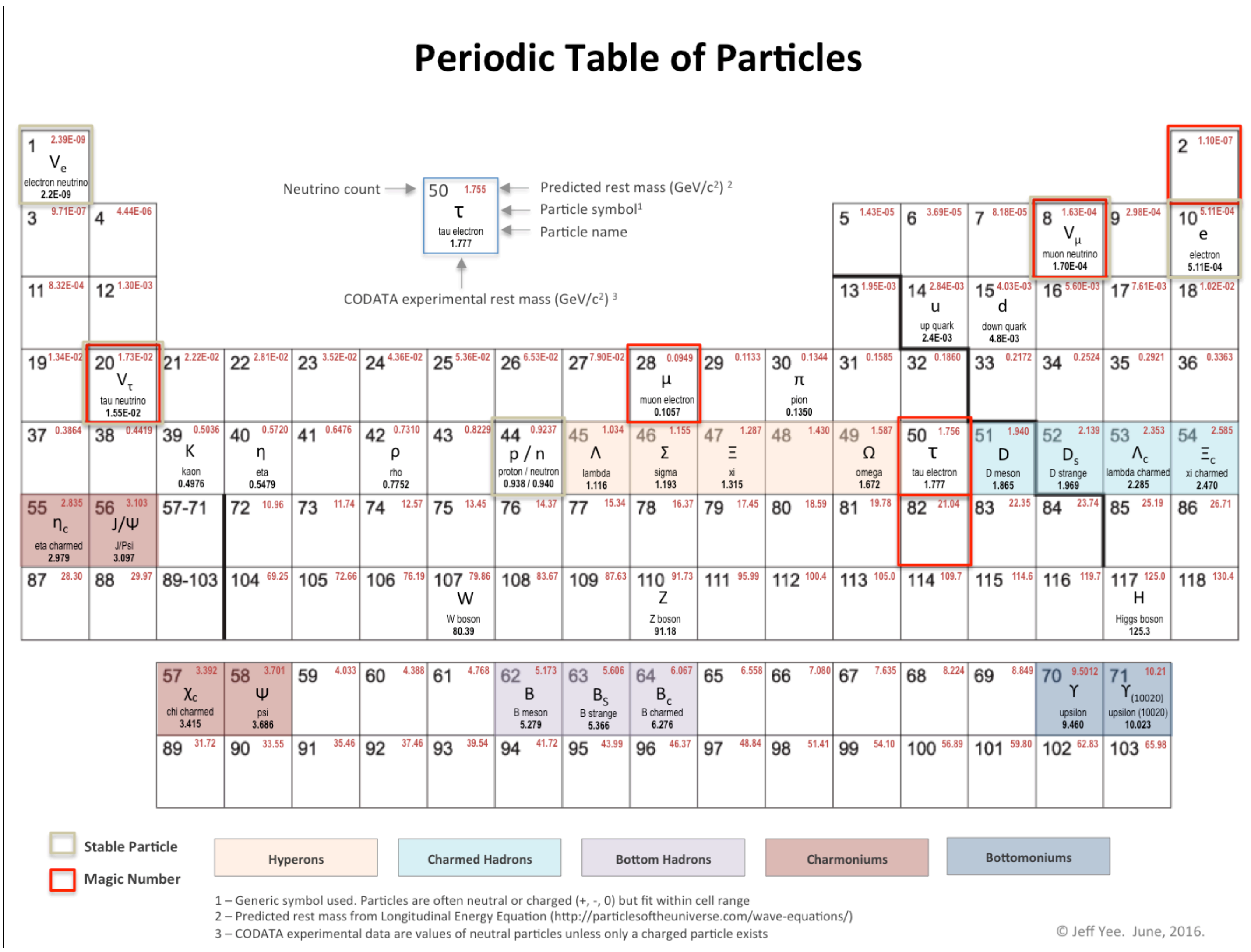
Elements. As an example, scientists at CERN may have witnessed a 750 GeV particle, heavier than the Higgs boson.[3] Using the Longitudinal Energy Equation, this would match a neutrino count (K) of 168 neutrinos, much larger than the current 118 atomic elements in the Periodic Table of Elements.

To illustrate the calculations using the Longitudinal Energy Equation, the first ten particles have been calculated in Table 1 below, similar to the calculation above in Eqs. 1.1 – 1.3. The results from the equations are in Joules (J), but then converted to GeV for easier comparison to known particles.

Core - Wave Centers (K)	1	2	3	4	5	6	7	8	9	10
Calculated Rest Energy (GeV)	2.39E-09	1.10E-07	9.71E-07	4.44E-06	1.43E-05	3.69E-05	8.18E-05	1.63E-04	2.98E-04	5.11E-04
Calculated Rest Energy (J)	3.83E-19	1.76E-17	1.56E-16	7.12E-16	2.29E-15	5.91E-15	1.31E-14	2.61E-14	4.77E-14	8.19E-14

Table 1 – Neutrino Count (K) for First 10 Particles

The steps above were repeated for neutrino count (K) from 1 to 118. The calculated values in GeV were then added to the Periodic Table of Particles below, along with known particles and their experimental rest mass values (also in GeV). Finally, colors were added to group particles with similarity as shown in the legend.



High Resolution Image - http://particlesoftheuniverse.com/universe/periodic-table-of-particles/

The upper-left quadrant of each cell in the table contains the neutrino wave count. The upper-right quadrant contains the predicted rest mass from the Longitudinal Energy Equation, and this is compared to the CODATA values from experiments for these particles, located at the bottom of each cell.[4] The values used for rest mass of particles are based on the neutral charge form of the particle, unless a neutral charge form did not exist. In that case, a charge form of the particle was used. Particles were then placed into the cell that best fit their experimental rest mass values.

Example – Tau Electron

The tau electron (τ) has a CODATA rest mass value of 1.777 GeV. It was placed into cell 50, which has a predicted 1.756 GeV rest mass value. Therefore, it has a neutrino count of 50.

Example – Kaons

There are three kaons (K). Two are charged particles (K^- and K^+) and one is a neutral particle (K^0). The rest masses are slightly different, which is explained below. K^- and K^+ have a CODATA rest mass value of 0.4937 GeV. K^0 has a CODATA rest mass value of 0.4976 GeV. Like other charged particles, the difference in rest mass value fits within the cell range, so only one particle was placed into the table. The neutral particle value of 0.4976 GeV was used and the generic kaon symbol, K, is placed into cell 39, which has a predicted rest mass of 0.5036 GeV. The kaons, charged or neutral, therefore have a neutrino count of 39.

The difference in particle mass for variations of a particle like the kaon requires explanation. There are two possible reasons. First, particles may have different geometric formations with the same neutrino count. These formations may lead to slight differences in constructive wave generation. The second reason may be the equivalent of isotopes at the subatomic particle level.

As an example, the first cell has a neutrino count of one (+1). This could be a simple formation of a single neutrino. However, it could also be another formation that results in the same standing wave count, such as two neutrinos (+2) and one antineutrino (-1). In this case, one neutrino and the antineutrino may essentially annihilate, where the result is the same as the first case 2-1=1. This is analogous to isotopes in atomic elements, although there are some differences. A helium nucleus, for example, might have three nucleons (two protons and a neutron). This is known as helium-3. Or, the more common helium-4 contains four nucleons (two protons and two neutrons). Subatomic particles organized in the Periodic Table of Particles have the same concept of isotopes, although it is based on an arrangement of neutrinos and antineutrinos, rather than protons and neutrons.

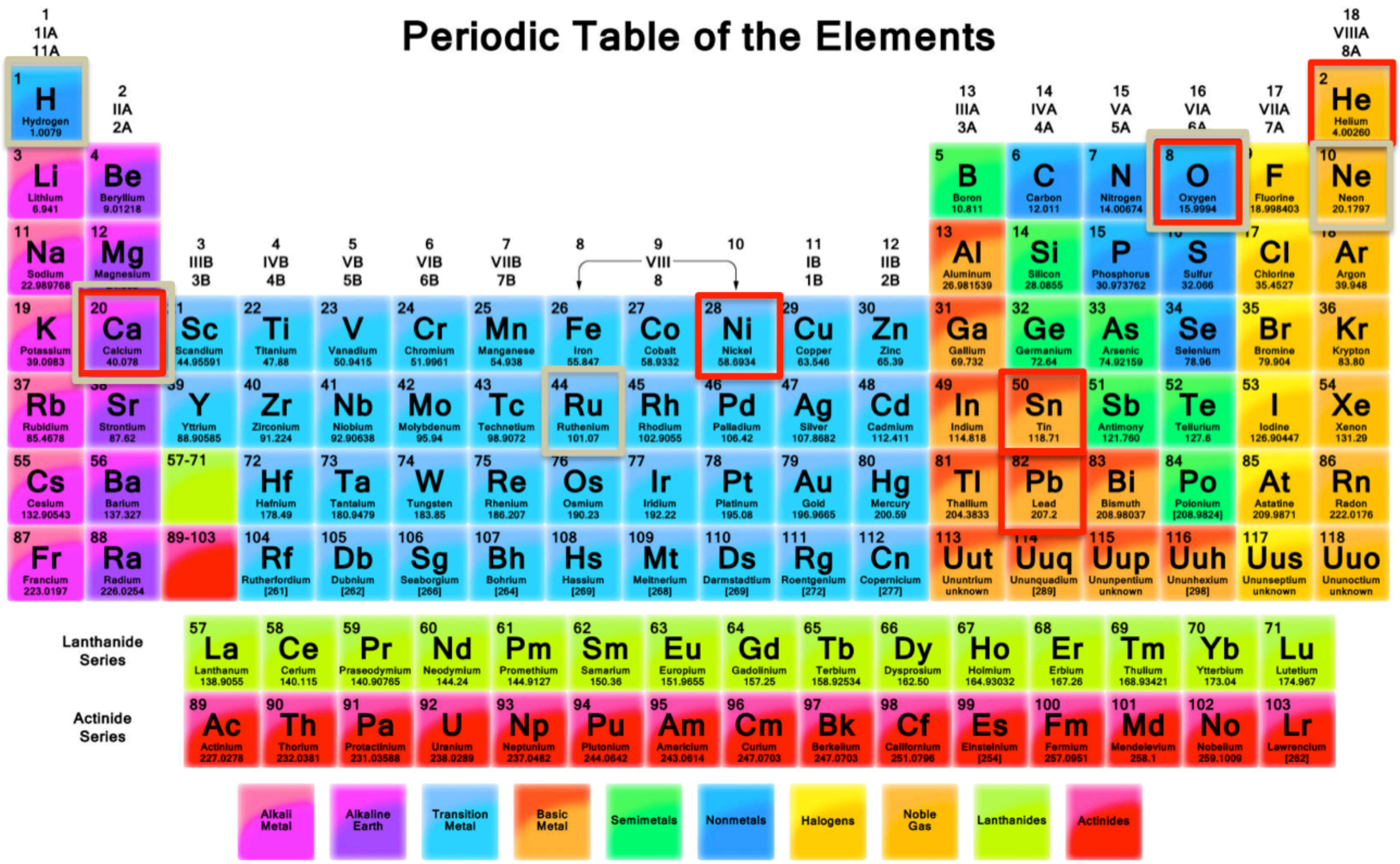
Legend – Colors & Boxes

Particles have been organized in common groups, such as hyperons, charmed hadrons, bottom hadrons, charmoniums and bottomoniums. These were sequential in the table and background colors were used to organize these particles.

Box outlines were used for commonalities that were not sequential in the table. For example, the neutrino, muon neutrino, tau neutrino, electron and proton are known to be stable particles. Boxes 1, 8, 10, 20 and 44 were marked as stable. Also, boxes 2, 8, 20, 28, 50 and 82 were marked as magic numbers as discussed below when compared to the Periodic Table of Elements.

Periodic Table of Elements

A revised Periodic Table of Elements was created to compare particles and their placement in the table against elements. The same colored boxes from the Periodic Table of Particles have been overlaid on the corresponding cells in the Periodic Table of Elements.



In comparing particles to elements, stable particles appear at 1, 8, 10, 20 and 44. Three of these particles map to the five most common elements in the universe (hydrogen, oxygen and neon).[5] Calcium is a larger element at 20 protons, yet is abundant within Earth's crust at 5%.[6] Only ruthenium sticks out as an element that is not common within our universe.

Also marked on the Periodic Table of Elements are the magic numbers: 2, 8, 20, 28, 50 and 82. It is no surprise that it maps to helium, oxygen, calcium, nickel, tin and lead, which are all common elements. Scientists studying the table and its characteristics initially discovered the magic number sequence. What makes it interesting is that leptons are found in this sequence in the Periodic Table of Particles (only 2 and 82 are undiscovered particles). Leptons occur naturally and do not undergo a strong interaction like many of the other particles in the table. These are some of the similarities found when organizing particles into a similar table structure that was built for atomic elements.

Using the Table

Numerous experiments are underway that may yield new particles. The middle range of the Periodic Table of Particles, cells 39-71, list many particles from particle accelerator experiments such as ones conducted at CERN. Now, new experiments at CERN are being run with increased energy, which may yield new particles at the higher range of the table. Similarly, neutrino experiments around the world are being conducted, which could lead to the discovery of new particles in the lower range of the table (particularly between cells 1-20). The table may be validated when additional particles are discovered and found to fit into available cells in the table.

The table may also be used to explain and start to decode the work on neutrino oscillation and particle decay. Neutrinos are known to oscillate, growing from a neutrino to a muon neutrino to a tau neutrino, or the reverse to become smaller, with no explanation. A combination of neutrinos forming in the core as they mix during flight, could answer why neutrinos are oscillating. According to the table, eight neutrinos in formation would create a muon neutrino, or 20 neutrinos would create a tau neutrino. If their geometric formations are not stable for each individual neutrino in the core to be at nodes on the wave (spaced at wavelengths), then the particle will decay. This may be a reason that the known neutrinos are at magic numbers in the table, which are also known to be stable in atomic elements as well.

The table may also be used to explain the decay of particles, although there is significant work remaining to complete this theory. One of the challenges with decay is that particles will decay in many ways. It's difficult to understand the true makeup of a particle when the sum of its parts do not match the whole, nor are the parts consistent with each experiment. It's like shooting an orange from a cannon, and sometimes it produces two lemons when it explodes, and other times, it produces three limes as its parts. Although decay remains a mystery, even after compiling the Periodic Table of Particles, there are hints that this is the right direction. The lower elements in the table have fewer options to decay. The pion (#30) decays one of two ways.[7] The largest particle in this table, the Higgs boson (#117), has been found to decay at least five ways, and more could still be discovered.[8] The neutrino (#1), meanwhile, has not been found to decay. As the particle's core neutrino count increases, there is a corresponding increase in the potential formations that created the particle and hence more options for decay.

The table can be used to explain the construction and decay of some particles, although there are many particle decays that cannot be explained with this model. This work is unfinished. However, the following are examples that do fit within the table structure and provide optimism that this model is a starting point for a different understanding of particle formation. The following are examples of a particle's makeup or its decay based on neutrino count.

Particle Markup and Decay Examples – Using the Periodic Table of Particles

Particle	Makeup[9]	Decay	Neutrino Count	Comments
Pion (#30)	up quark (#14) + down quark (#15)		14 + 15 = 29	Margin of error: -1 (*29 vs 30*)
Proton (#44)	up quark (#14) + up quark (#14) + down quark (#15)		14 + 14 + 15 = 43	Margin of error: -1 (*43 vs 44*)
Neutron (#44)	up quark (#14) + down quark (#15) + down quark (#15)		14 + 15 + 15 = 44	Margin of error: 0 (*44 vs 44*)
Kaon – K^+ (#39)		muon electron (#28) + muon neutrino (#8)	28 + 8 = 36	Margin of error: -3 (*36 vs 39*) for the most common decay mode.[10]
Tau Electron (#50)		pion (#30) + tau neutrino (#20)	30 + 20 = 50	Margin of error: 0 (*50 vs 50*) for the consistent particles in decay modes.[11]

				Neutral pions, or charged pions that annihilate, appear in some decay modes but the pion and tau neutrino are consistent components in all modes.
J/Psi (#56)		muon electron (#28) + antimuon electron (#28)	28 + 28 = 56	Margin of error: 0 (*56 vs 56*) for a common decay mode.[12]
Higgs Boson (#117)		bottom quark (#59) + antibottom quark (#59)	59 + 59 = 118	Margin of error: +1 (*118 vs 117*) for the most common decay mode.[13] *Note the bottom quark is not listed in the table, but based on its mass (4.18 GeV), it would be #59 in the table.*[14]

Other noteworthy observations in the table include:

- The heavy quarks (strange, charm, bottom and top) were excluded from the table because they would conflict with some particles in the table. Their values would be: strange quark - #28, charm quark #47, bottom quark - #59. The top quark would exceed the limits of the table.

- Heavy quark decay produces mesons: pions (#30), kaons (#39) and D mesons (#51). These are roughly the difference of an electron (#10). The decay of the bottom quark produces D mesons; the charm quark produces a kaon; and the strange quark produces a pion. [15] Therefore, the difference in these quarks may be the addition of an electron.

- Hyperons, charmed hadrons and charmoniums fit nicely in the table sequentially from #45 - #58, with the exception of a break for a lepton, the tau electron, in #50. #48 is the only empty cell in this range. Xi Resonance, a hyperon, with a rest mass of 1.531 GeV, is within range of this cell but may be closer to cell #49 and was excluded from the table.

Conclusion

Subatomic particle research should consider a model similar to the atom, which is organized based on its atomic charge. Elements found on Earth, and seen across the universe, are formed from a simple structure of atoms and the configuration of protons (with electrons playing an important supporting role). As things become smaller, nature does not go from complex (elements) to simple (atoms) to complex again (particles). This paper argues that particles are simple, formed from a common building block of wave centers, known as the neutrino.

The Periodic Table of Particles was put together for entertainment, showcasing similarities of particles and atomic elements. There are certainly commonalities between them that warrant further investigation into this model. However, the structure of the table only accounts for mass, and a table should eventually be reorganized to account for the spin and charge of particles, and possibly color, depending on its relevance in this new model.

Understanding the makeup of particles and their decay is improved with a theory based on a fundamental building block. Particles don't mysteriously oscillate or decay to become vastly different particles. They add or remove the same building blocks, based on a single fundamental particle, the neutrino. However, the explanation of particle decay modes in this paper is inadequate. A handful of decay modes match the table structure and theory, a few others were within a reasonable margin of error to make the table interesting, but dozens of other decay modes were not included in this paper because there is no explanation based on the Periodic Table of Particles. There is more work and research to be done to understand why particles decay in very different ways. Yet, the table structure provides some proof that this may be the right direction for future research.

Further proof may come from confirmation of new particles that fit within missing cells in the table. High-energy experiments at CERN and neutrino experiments around the world will likely find new particles. When they are found, it will be time to consider if there is yet another particle in a complex world, or if we are living in an era similar to Mendeleev, where the complex can be explained with a simple, rational answer. If this were the case, the answer would be that particles are made from one common building block - a wave center of energy, forming standing waves, measured as mass. The lightest particle, the neutrino, assembles in geometric formations that may or may not be stable, to create particles, which create atoms, which finally creates matter. This is the wave structure of matter.

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