Title: Challenging fractional charges of quarks through assigning integer charges and proposing nucleus structure

Author: Francois Zinserling – 2018
NB: This paper is of a speculative nature.

Abstract 3
Key Words....3
Introduction 3
Charge of the quarks since 1964....3
Quarks are not detected because they are ‘confined’ 4
Proton and Neutron spin 4
Unresolved science 5
Observable evidence in support of this paper....5
General postulates of this paper: 5
Electrostatic charge has no fractions....7
Calculation of elementary charge:....7
Charge independence of particles and no fractional charges 8
Building a model for a proton and a neutron. 9
Spatial structure of a proton and neutron....9
Proton and neutron charge distribution 10
Mass and size of particles....12
Length contraction and size reduction....12
Magnetic Dipole Moment as motivation for particle size 12
Energy as motivation for particle size 13
Frequency generation as motivation for particle size 14
Representation of size....14
Particle mass and size 15
The missing mass in the proton and neutron 15
Particles can be confined 16
The structural model – of a proton and a neutron, with charges of particles 17
Testing method for assigned charges....17
Definitions (as per this hypothesis): 18
The model: Proton and neutron – Spin and Magnetic Dipole Moment....18
The model: Where is the neutrino 20

- The model: How does the electron get captured? ... 22
- The model: Proton and neutron – nuclear reactions ... 23
  - Explanation: Proton is converted to neutron ... 23
  - Explanation: Neutron decays to proton ... 24
- The model: Proton and neutron – shell model with charges and spin: ... 25
- Proton and neutron charge distribution ... 26

Final summary of conclusions ... 27
- Charge ... 27
- Confinement ... 27
- The model ... 27
- Additional conclusions ... 28

Acknowledgments ... 28

References ... 29

Supplementary Information ... 33
- Where are the other baryons and mesons in this model? ... 33
- Sample structure: Helium. Strong bond. ... 33
- Sample structure: Carbon ... 35
- Sample structure: Nitrogen ... 35
- Neutron and Proton mass ... 35
- Tests that could be conducted, and further studies required ... 37

Challenging fractional charges of quarks

Abstract

Fractional charges are not required to represent elementary particles, shown here through analysis of elementary charge equations. This paper offers a speculative proposal for a structural model of the proton and neutron, with intuitive nucleus and atom structure, containing elementary particles of only integer charges. This proposal also seems to provide answers to some of the less understood current observations, such as missing anti-matter, proton stability, electron capture, neutron instability, helium stability, and may merit further investigation to improve our understanding of atomic nuclei.

Key Words

quark integer charge, proton neutron structure, z-particle, electron capture, missing antimatter

Introduction

Protons are said to consist of two types of quarks, containing 3 quarks, UUD (up-up-down) quarks, and the neutron containing UDD (up-down-down) quarks. Up quarks are said to have (+2/3) of the elementary charge, and down quarks have (-1/3) charge.

Quarks are listed in the standard model of elementary particles. In 1964 Gell-Mann and Zweig[1,2,3] proposed a nucleus containing three particles (later named quarks), with charges equalling fractions of the elementary charge. This proposal followed their highly successful SU3[4] symmetry scheme, as proposed in 1961, which created an order in the ever-increasing list of detected hadrons[5,59] – baryons and mesons. SU3, at that time, included combinations of the up, down and strange quarks, and their anti-particles. While satisfying the requirement for particle charge, an UUD set (proton) would also have a resultant UP spin, and an UDD set (neutron) would also have a resultant DOWN spin.

Despite quantum theory's success[42,58] at predicting, calculating, and describing Standard Model particles, quarks have not been detected, and neither has any other particle with a fractional charge ever been detected. Abstract theories such as "valence quarks", "confinement", "colour-force" and "sea-of-quarks-and gluons" – have been added, yet none of these proposed quark properties have been observed. It needs to be remembered that Gell-Mann introduced quarks as a purely mathematical abstract, and not as particles yet to be discovered[2].

Quantum theory is an elegant mathematical tool[42], with extremely accurate predictions, but without the ability to *explain* what happens during an experiment. This should be an alarming indicator that we do not correctly understand some of the fundamentals.

Charge of the quarks since 1964

The charge of the proton is (+1)[1,2,3], an exact measurable positive elementary charge, and the charge of the neutron is (0). To achieve this charge within the quark model, charges had to be assigned as (+2/3) for the up quark, and (-1/3) for the down quark. This is such that the proton with UUD (up-up-down) quarks and neutron with UDD (up-down-down) quarks would match their observed charges.

It was further observed[6] during the decay of a neutron (0) to proton (+1) that an electron (-1) is ejected from the process, and it was said that a down quark (-1/3) would decay to an up quark (+2/3) through interaction with a W^- boson. Result is a proton with charge (+1), plus the ejected electron (-1).

In proton fusion, an up quark (+2/3) in the proton (+1) decays to a down quark (-1/3) through a W^+ boson, and a positron of charge (+1) is ejected. It is also possible for a proton (+1) to capture an electron (-1) in rare cases. The result is a neutron, charge (0).

Quarks are not detected because they are 'confined'

No quark or any particle of fractional charge (+2/3) or (-1/3) has ever been detected in isolation. All fractional charge particles are inferred and are proposed to have taken part in processes leading to observable results. Many particles are detected though, but these *all* have charge of (-1), (0) or (+1) (and integer multiples there-of).

To deal with this problem facing the original theory, new theories were put forward. The theory which sprang forward to explain the lack of quark observations claims that quarks are held so tightly in the nucleus that they cannot be released. "Quark confinement"[1,7] and "colour force" theories followed one another to clarify the lack of fractional charge direct observations. A "sea of quarks and gluons" and "valence quarks" were added to the theories to explain the missing mass of particles.

Proton and Neutron spin

Elementary particles (fermions) are known to be spin ½ particles[43]. Spin is an additional quantum number that was assigned when it was found that two electrons could occupy the same quantum state. By assigning +½ and -½ to their spin, the electrons were there-after uniquely defined, could occupy the same space, and therefore do not violate the Pauli Exclusion Principle[30]. Spin is also linked to the magnetic dipole moment of particles, where fundamental particles have values of magnetic dipole moment linked to their mass and electric charge.

With the proton as a (+1) charged particle, and a measurable magnetic dipole moment, it was assigned the status of a spin ½ particle.

Because the neutron charge is zero, it was first expected to have no spin and no magnetic dipole moment. Beta decay of a neutron results in a proton, electron and electron-anti-neutrino. Pauli proposed the neutrino in 1930, to explain how energy, momentum, and angular momentum (spin) could be conserved during beta decay. Sherwood, Stephenson, and Bernstein employed neutrons in a Stern–Gerlach experiment[45] that measured the neutron in two spin states, thereby also defining it as a spin = ½ particle.

The proposal of Gell-Mann and Zweig[1,2,3] not only resolved the charges of the proton and neutron, it also allowed them both to continue to be spin ½ particles. This was partly the reason the quarks were named 'up' and 'down', to show the proton as a net spin 'up' particle, and the neutron as a net spin ‘down’ particle, because the spin of the other ‘up’ and ‘down’ in each nucleon cancel out.

This, however, created a new problem as to how 2 identical ‘up’ particles can co-exist in the proton, and 2 identical ‘down’ particles in the neutron, thus violating the well-established Pauli exclusion principle. By assigning new ‘colour’ charges to the quarks, they were given newly defined unique quantum properties, and once again physics was at peace.

Unresolved science

This document aims to propose an alternate path which may have been explored by Gell-Mann and Zweig, had they considered only the elementary charge. The following science is questioned here-in:

- The proton and neutron are said to contain 3 valence quarks: proton = up, up, down, and the neutron = down, down, up – but these quarks have not been observed.
- The up- and down quark are said to have charges of (+2/3) and (-1/3) respectively. No fractional charge particle has been observed.
- Proton and neutron structures are not understood. The quarks are contained in a “bag” in the proton and neutron, structure undefined. Yet atoms are known to have extremely well-defined structures.
- Quark masses are low, and the rest of the mass of the nucleus is made up of a “sea of quarks and gluons”.
- Difference of mass between proton and neutron is not well understood. The decay of quarks does not account for this mass difference.
- Anti-particles (+) positrons are lacking in numbers, compared to the amount of observed (-) electrons.
- During electron capture, the electron is ‘transformed’ via a W-boson.

Observable evidence in support of this paper

- Each elementary particle, which makes up the fundamental fermions, including the electrons and positrons, carries an elementary charge of the exact same positive (+) or negative (-) magnitude. This charge is independent of energy or mass of the particle and is a constant of nature.
- Elementary (+) *and* (-) particles can be born out of the vacuum via pair production.
- Electrons are observed to enter and exit the nucleus during certain beta decays.
- Neutron charge distribution has been observed by Miller[37], showing an unexpected (-) charge toward the centre.

General postulates of this paper:

- Elementary (+) *and* (-) particles can be born out of the vacuum via pair production. Therefore, also, pair production is possible inside the nucleus.
- Various (+) and (-) particles in the proton and neutron exist at unique discrete energy levels inside each nucleus.

- Annihilation and escape of adjoining (+) and (-) particles is prevented in the nucleus because of mass and size differences, and other quantum properties (e.g. spin) preventing annihilation.
- An elementary particle's physical size is inversely proportional to its energy. (not a new postulate, but this paper extends this to non-relativistic particles)
- Elementary particles are contained inside the nucleus by electrostatic and electromagnetic attraction. Because of the mass and binding of these particles, attempts at dislodging the particles will likely result in pair production at levels of the probing energy.
- If a fundamental particle is not stable at a current energy level, it will attempt to release part of its own energy by releasing e.g. a photon, and relax (expand, enlarge) to a stable lower energy. If it is bound stable, or at its lowest allowed energy level, it will not (cannot) do so. If a particle may gain enough energy by e.g. absorbing a photon, it will collapse (contract, shrink) and may fit into a smaller spacial position.
- (-) Electron is prevented from spontaneously 'falling into' the nucleus due to (+) sub-particle spin conflicts and can only be captured into the nucleus when particle spins are aligned in a specific arrangement, *and* the electron has sufficient additional energy.
- Electrons, as they are currently known, can be found in various orbitals around the proton, each level associated with its own orbital energy. At different energy levels, the electron or the atom do not get renamed. In fusion reactions examples occur where the electron enters, and where the electron or positron exits the nucleus, yet it is not currently acknowledged to be *in* the nucleus. This document proposes that electrons (-) and positrons (+) are also found at higher mass-energy levels *inside* the nucleus of the proton and neutron, making up the nucleus structure.
- A neutron contains an equal number of (+) and (-) particles, but at different energy levels.
- The proton contains an unequal number of (+) and (-) particles, but at different energy levels. There is one more (+) than (-) particles in the proton.
- The missing anti-matter is in the nucleus. Total #(+) = #(-)
- From the model it is shown how e.g. helium is an ultra-stable particle.

Electrostatic charge has no fractions

An accurate measured value for the elementary charge is available, and a primary equation exists for the calculation thereof[8]. The exact same charge, opposite in sign, exists in all electrons and protons – two distinctly different particles. The electron, muon and tau, each with a distinct mass, all share this exact same (-1) charge. This paper proposes that the Standard Model erroneously proposes fractional charges for quarks. This section shows here that fractional charges cannot exist in elementary particles.

Calculation of elementary charge:

Elementary charge e = (+/-) 1.6021766208E-19 Coulomb[8]

Coulomb's law[9] states that: "The magnitude of the Electrostatics force of interaction between two point charges is directly proportional to the scalar multiplication of the magnitudes of charges and inversely proportional to the square of the distances between them."

Electrostatic force: $$|\mathrm{F}| = \frac{\mathrm{k_e} * |q_1 * q_2|}{\mathrm{r}^2} \quad \textbf{(1)}$$

F = Electrostatic Force (N); k_e = Coulomb constant (Nm^2/C^2); q_1, q_2 = charges (C); r = distance between charges (m)

The energy of the particles can be defined as:

Energy E = F(r).dr (E_0=0): $$|\mathrm{E}| = \int_0^r \frac{\mathrm{k_e} * |q_1 * q_2|}{\mathrm{r}^2} \quad \textbf{(2)}$$

$$|\mathrm{E}| = \frac{\mathrm{k_e} * |q_1 * q_2|}{\mathrm{r}} \quad \textbf{(3)}$$

or $$|\mathrm{E}| = |F| * r \quad \textbf{(4)}$$

Since the magnitude of positive and negative charges are the same,

$$|q_1| = |q_2|, \text{ so } q_1 * q_2 = Q^2 \quad \textbf{(5)}$$

From Eq3 and Eq5: $$E = \frac{\mathrm{k_e} * Q^2}{r} \quad \textbf{(6)}$$

Since 'E' is not known for any 'r', the correct value of Q cannot be obtained from this equation alone. In 1909 Robert Millikan and Harvey Fletcher[10] measured E successfully.

For the 'r' in Eq6, use the single electron radius as first proposed by Niels Bohr in 1913[11] and adapted by Arnold Summerveld in 1916[12]

Classic electron radius: $$\mathrm{r_e} = \frac{\alpha * \lambda_e}{2 * \pi} \quad \textbf{(7)}$$

r_e = electron radius; α = fine structure constant; λ_e = Compton wavelength of the electron

from Eq6 and Eq7: $$E*\frac{\alpha*\lambda_e}{2*\pi}=\mathrm{k_e}*Q^2 \quad \textbf{(8)}$$

From the Max Planck-Albert Einstein energy formulations[13], and the Compton wavelength:

$$E=\frac{h*c}{\lambda};E=h*f;E=mc^2 \quad \textbf{(9)}$$

h = Planck's constant (Js); c = speed of light in a vacuum (m/s)

Energy * Wavelength is a constant: $$E*\lambda=h*c \quad \textbf{(10)}$$

Considering there are two particles, total 2E, at a distance of 2r apart:

from Eq8 and Eq10: $$Q=\pm\sqrt{\frac{\alpha*h*c}{2*\pi*k_e}} \quad \textbf{(11)}$$

reveals: Q = ± 1.6022E-19 Coulomb **(12)**

Charge independence of particles and no fractional charges

From Eq10, E*λ is a constant. The above derivation must apply to all elementary charged particles.

Even though the electron wavelength was used in the equation above, it falls out of the final equation; hence the electron charge is not dependent on the electron wavelength at all. If the quark is an elementary particle, such as the electron, its charge cannot be dependent on its mass or energy, or size or wavelength.

From Eq11 it is seen that charge Q is not dependent on the frequency, mass, energy, or wavelength of a particle, only on a set of known constants. It was shown mathematically how elementary particles of different size (or mass) have the exact same charge value, or the opposite sign.

None of the constants in Eq11 are known to succumb to fractions. This solution above offers no room to assign fractional charges (+2/3) or (-1/3) to particles, as currently described in the Standard Model. The charges of sub-particles in the proton and neutron must thus be assigned only (+1) or (-1), as are all elementary particles, and the proton and neutron structure must be re-examined and adapted to suit.

Building a model for a proton and a neutron.

Spatial structure of a proton and neutron

A proton is said to contain an UUD combination of valence quarks, and a neutron contains an UDD combination of valence quarks[15] (gluons and sea of quarks not shown here in Figure 1)

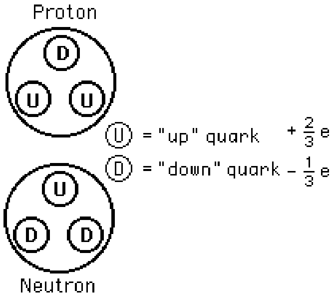


Figure 1: Conventional way of showing quarks[16]

Figure 1 was an early attempt at giving the proton and neutron defined structures from quarks, which had since been revised when the quarks were not detected, and the mass of each of the quarks was not found to be around the expected value of ~1/3 of the proton mass. However, structure still needs to be taken into consideration to explain how molecules of the same elements would appear structurally very much alike.

Here this hypothesis finds the "sea of quarks", and the "valence quark", and the "quarks in a bag", and "quarks and gluons" models troublesome. Not only because these are theories born from a lack of observation, but also because: How would this not lend itself to be a formless mass, unable to attain or retain a regular structure in an atom?

To suit convention, a group of integer charge particles would be best presented graphically in a nuclear version of the electron shell model, or in a molecular geometry-type structure. Georges Sardin makes a compelling argument for the negatively charged shell around the neutron in his nuclear shell model[39]. However, this paper proposes a different solution.

Through protons, neutrons and electrons, the quantum world begins to give structure to the universe of matter as we know it. Electrons attach to sets of protons and neutrons to form atoms, which are reliably structural. Therefore, sub-structure in protons and neutrons should already hint at how larger (atom) structures are reliably formed. This paper will attempt to give structure to protons and neutrons.

Postulate and requirements of this hypothesis: If the protons and neutrons were to be given structure through internal integer charged elementary particles, the particles must be of types to assist with forming structure. It cannot be found to have little or no participation in exchanges with other similar-sized particles. It can also not be too electron-like and be allowed to partake freely in chemical-like reactions within the atom. The proton should be visibly stable and there should also be a hint toward the neutron's instability. A neutron should be able to decay into a proton. There should be a hint how the proton and neutron would fuse, and how some particles are stable, and others are not.

Proton and neutron charge distribution

Shown below in Figure 2 is the conventional radial (squared) dependence of the charge densities of the proton and neutron[38]. The approach to zero at r=0 for both proton and neutron is due to the r^2 component. Both proton and neutron are shown to have a (+) peak at a small distance from the centre. Proton (+) charge drops away over distance but remains positive, while the neutron positive charge drops away rapidly and then appears to have a shell of negative charge surrounding the peak of positive charge, eventually levelling out to a net charge of ‘zero’ observed at a distance.

This distinct distribution is not likely in a ‘sea of quarks and gluons’ and attempts at describing this charge distribution through the presence of up (+2/3) and down (-1/3) valence quarks have not been successful.

To begin to imagine a model with integer charged particles from this graph only, the proton might need only one (+) particle with some varying radial charge distribution, and the neutron might only need one (+) and one (-) charged particle, to satisfy their net charges. However, such a solution would require the proton to be a fundamental (+) particle and is thus not considered as an option any further.

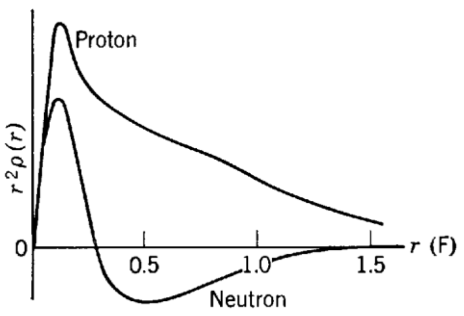


Figure 2: Nucleon charge density[38]

Consider the charge distribution of the neutron as proposed by Gerald A. Miller[37] in Figure 3 below. An additional (-) charged area is shown at an inner radius. Although Miller ascribes this distribution possibly due to quarks, his observation is an important consideration in this document.

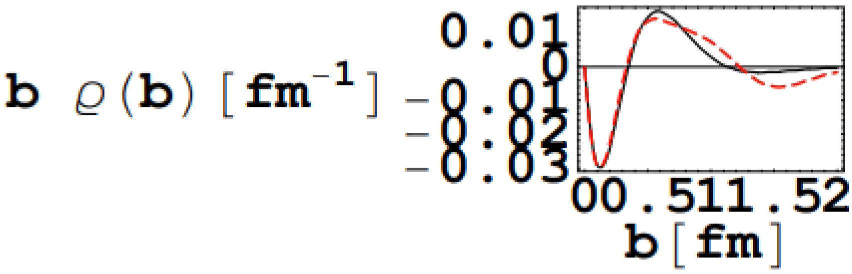


Figure 3: Neutron Charge distribution (Miller[37])

Since the (-) charges in Figure 3 are not overlapping, it is expected to find at least two distinct (-) charged particles, or at least regions of (-) charge, in the neutron. One inner and one outer. Considering these two (-) charges; To satisfy the required net (0) charge of the neutron, an equal amount of (+) integer particles (two) would thus need to be present in the neutron. This document proposes to explore and substantiate this option.

Mass and size of particles

Length contraction and size reduction

While investigating the ‘quantum world’, one’s ‘real world’ intuit related to size must be inverted. For a given density, more ‘real world’ mass means more size. However, in the ‘quantum world’, the higher the mass, the higher the energy, the *smaller* the size. The Compton wavelength of elementary particles speaks to this, just as the wavelength of a photon does.

Smaller, for an elementary particle, would mean its probability wave-function is spread over a smaller spacial length, hence it takes up less Minkowski space. This requires more energy.

This document does not consider particles as point-like. Point-like properties assist greatly in Quantum Theory calculations, but so do gravitation calculations for stellar objects, which are known to be *not* point-like.

The more energy a photon has, the smaller its wavelength, and the less space it takes up. When an ordinary light-microscope cannot provide the required resolution to probe an object, an electron-microscope is used, because an electron wavelength is ‘smaller’ than the wavelengths of visible light. To probe even smaller spaces, muons are used[36], because the muon wavelength is again smaller than that of the electron. In Schrodinger’s terms, the muon could occupy a smaller box than an electron.

Being of wave and particle nature, it may be reasoned that, just like a photon [where E=hf], any elementary particle’s size will be reduced when it gains, *and holds*, additional energy. (not kinetic energy**)

**It is known that a particle with high energy, such as a particle travelling at high velocity, will experience a length contraction in the direction of travel, as seen from an observer that is in a relative frame ‘standing still’ (Einstein 1905)[14]. However, this paper considers only the rest mass of particles, not velocity, therefore relativistic contraction is not considered here. Just as a muon is smaller than an electron, this paper suggests that any elementary particle reduces in size when it gains energy.

By the same logic, the above arguments do not apply when mass is gained by adding more particles. Once bound into structure, additional mass adds up to size in ‘real world’ counts. A composite particle may still reduce in size if the sub-components gain energy, (e.g. neutron star) but the overall mass-to-size relation cannot be relied upon anymore. For composite particles, the Compton wavelength becomes meaningless.

Magnetic Dipole Moment as motivation for particle size

It is known that for the electron and muon, two different mass particles, the Bohr magneton equation Eq13 is valid:

Bohr Magneton: $$\mu_B = \frac{g * q * \hbar}{2m_q} \quad (13)$$

(with g = 1.0011 is the g-factor of the electron), and it is found that since the electron mass is lower than that of a muon, it has a higher magnetic dipole moment (MDM).

From Dirac, and Eq13, mass*MDM = constant.

	mass (kg)	MDM(J·T−1.)	mass*MDM=constant
electron	9.10938356E-31	-9.28476400E-24	-8.45784765E-54
muon	1.88353159E-28	-4.49044780E-26	-8.45790030E-54

Table 1: Relation of mass*magnetic moment for fundamental particles

If the classical comparison of magnetic moment to a current loop is examined[41], from the relation for the current loop in Figure 4:

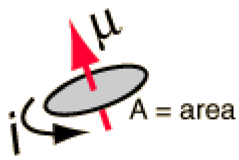


Figure 4: Magnetic moment of a current loop. (Image credit: Hyperphysics)

Magnetic moment of a current loop: $$\mu = I * A \quad (14)$$

Eq14 shows that a larger area creates a larger magnetic moment (for the same current). Eq13 also shows that a smaller mass fundamental particle will have a larger magnetic moment. This may be counter-intuitive but indicates that a more massive fundamental particle must be spatially smaller than a lower mass fundamental particle.

Deduce from this that the electron is spatially larger than the muon.

The above relation does not hold for composite particles such as protons, neutrons, or atoms, because magnetic moments of fundamental particles within a structure may add or subtract.

Energy as motivation for particle size

Shown here in Eq15 is the Einstein Planck relation[13], using the Compton wavelength, where the energy of an elementary particle is given:

Particle energy: $$E_p = \frac{h * c}{\lambda} \quad (15)$$

Suppose in the middle of a room is a particle of mass-energy E_1. Two photons are released, each of energy E_2, at opposite ends of the room, both perpendicular to the travel of the particle, to coincide with the particle on its path at the exact same moment. The particle absorbs both photons. Hereby the energy of the particle is (momentarily) increased without adding any kinetic energy. If the particle does not immediately release the energy gained, it has increased its own energy to $E_3 = E_1 + 2*E_2$, (and therefore increased its mass), to a higher $E_3 > E_1$. Which means for the higher mass λ_3 is smaller than the lower mass λ_1.

Frequency generation as motivation for particle size

In a musical instrument, it is generally found that smaller instruments (of the same type) produce higher frequencies. A small child's guitar cannot produce the long wavelengths achievable by a long string instrument. By pressing a finger on a guitar-string, the string is effectively shortened, and a shorter wavelength is emitted. Shorter wavelengths carry higher energy.

The frequency of radiation emitted from nuclei is much higher than radiation from electrons[40], which again indicate that the wavelengths emanating from the nucleus are of smaller wavelength because they come from a source of smaller size. Even though a nucleus is a composite particle, consensus is that it is made up of particles more massive than an electron. Nuclei are more massive than electrons but are smaller in space.

Deduce from this that the electron must be larger than the proton nucleus.

When an electron gains energy, sufficient to attain a higher orbital (by convention), it will shed the energy again if the lower orbital is not filled. The more energy it can absorb before releasing it again, allows it to attain even higher orbital energies, but for a shorter time than at lower energies. The photons released from these higher energies are not only of higher energy, they are also released more frequently. By the above hypothesis of this document, this is intuitive of an electron that gets smaller when it gains more energy and releases higher frequencies. It is non-intuitive to think that it has gained more kinetic energy and oscillating – a greater distance – faster.

Representation of size

Since λ is proportional to particle size, this paper will use λ (Compton wavelength) as a proportional indication of the size of linear space a fundamental particle would occupy, as shown below in Figure 5. (For this paper, particle shape is *not* implied, and the intention is not to suggest that λ is an *exact* measure of size.). In Figure 5, the 'spatial bigger' elementary particle #1, is the particle with the lower mass.

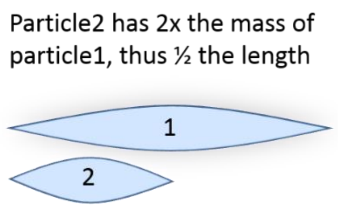


Figure 5: Particle size and mass relation

The reader must adjust his or her intuition, to understand that e.g. a proton (or e.g. a muon) is smaller than an electron. An elementary particle of mass e.g. 100MeV would be much smaller than an elementary particle of mass e.g. 1MeV.

Particle mass and size

The relationship between mass and size of an elementary particle was already stipulated by Planck and Einstein in the early 1900's. This pertains to a stationary particle's size, not relativistic.

The missing mass in the proton and neutron

Postulate: In the proton and neutron is a high-mass particle (here-in called z-particle), which makes up the majority of the mass of the proton and neutron, and acts as a mass-and-charge anchor, together with other lower-mass elementary particles and binding energies.

The Standard Model proposes 3 quarks for protons and neutrons, but this model considers other elementary integer charged particles. Consider the masses[20,21] of the 'quarks' in Table 2. With just three quarks assigned, even accounting for mutual binding energies, it does not define all the mass-content of a proton and neutron. The greatest mass component of the proton and neutron needs to be identified.

Mass	Quarks	Mass (MeV/c^2) (average)
m_1	Up	2.3
m_2	Down	4.8
m_p	Proton	938.3
m_n	Neutron	939.6

Table 2: Mass of up & down quarks, proton, and neutron

Here this hypothesis also disregards the "sea of quarks and gluons" as an explanation of the remaining mass and continues to look for a simpler structure.

A large portion of the mass is unaccounted for. This paper hypothesises that the formation of the most basic particles and structures – protons and neutrons – had to be a relatively simple process. If protons and neutrons were first formed from fundamental particles in a rapidly cooling universe, some signature component should be seen in these composite particles that equates to such an event, and that is not easily reproducible under current cosmic conditions. The missing mass above is proposed to be such a particle.

'It is a well-known fact that at energies above $\sqrt{s} \sim 20$ GeV all hadronic total cross sections rise with the growth of energy.' See within reference[35], its own references [1],[2],[3]. This paper suggests the rise in cross section is due to interactions with a more massive particle that only begins to show up at higher energies.

Particles can be confined

Schrodinger[22] and Heisenberg[23] both agree that an electron cannot be confined in the nucleus. Both assume that someone is trying to confine an electron with mass ~0.511 MeV, and radius $\sim 10^{-10}$m into a nucleus of size $\sim 10^{-15}$m. The resultant probability[24] is an exceptionally low $\sim 10^{-14}$. This is about as silly as trying to push a fully inflated soccer-ball into a thimble, with an added rule that it may not deflate while doing so.

However, if the electron absorbs enough energy to shrink to muon$^-$ or tau$^-$ size, to sub 10^{-15}m, the confinement event above becomes more probable.

According to the Heisenberg uncertainty principle[23], the minimum energy required to contain a particle of mass 'm' in a 3-dimensional box of length 'L' can be calculated as:

Confinement energy: $$E_c = \frac{9\text{h}^2}{8mL^2\pi^2} \qquad \textbf{(16)}$$

Particle energy[14]: $$E_p = \frac{h*c}{\lambda}; E = mc^2 \qquad \textbf{(17)}$$

It has already been shown that more massive fundamental particles occupy smaller space. Relating to Equation (16) above, more 'm' (mass) will give less 'L' (size), and since there is an L^2 component under the dividing line, a higher mass will require higher confinement energy.

Noting Equation (16), while probing for particles (quarks) inside a proton in a collider, at energies exceeding 1.022MeV, an electron and positron pair has a high probability to be spontaneously produced, if the confined particle mass (m) and confinement space (L) is such that $E_c >> 1.022$ MeV.

Smaller, more massive particles, bound in structure, will have (require) a higher confinement energy. 'Quark confinement' is thus not required. Elementary particles, (+) and/or (-), not fraction charged quarks, should be revealed in the LHC data if we look for it.

The binding energies shown above are attainable in a proton and neutron of ~940 MeV, but since the binding produces negative energies, and tends to hide mass, when all particle masses and confinement energies are added up, the total mass of all the individual particles (unconfined) will be (much) higher than the proton mass.

The structural model – of a proton and a neutron, with charges of particles

An attempt is made here to assign charges to the elementary particles, in the proton and neutron.

Previous alternative models of integer quarks have not been well accepted[25,26,27,28,29,33,39,44]. Charges originally assigned in the current Standard Model were done so to achieve the required answer of (+) for a proton and (0) for a neutron, and to conserve symmetry, using theoretical fractional charges assigned to a system containing three particles (quarks). The model presented here contains no fractional charges.

A graphic concept model is added, with integer electrostatic charges of elementary particles, in protons and neutrons, concluding with a speculative model of proton fusion and neutron decay, as examples of this model, where interacting charges, particles and forces are shown. Basic atom structure is also proposed in a shell model.

Testing method for assigned charges

The proton and neutron are understood to be composites of fundamental particles. In proton fusion reactions, the first core reaction is a proton-proton combining to form a proton and a neutron (plus positron and neutrino). When a neutron decays, it decays into a proton (plus electron and anti-neutrino). The proton is a stable structure and needs added energy to fuse. The neutron is unstable and if left alone, will decay spontaneously within minutes.

A theoretical test is proposed:

For the integer charges in particles in protons and neutrons to be valid, the assignments must adhere to at least all of the conditions below:

a. $N^0 = 0$: Neutron must contain (+) and (-) particles, with a net charge of (0).
b. $P^+ = (+)$: Proton must contain (+) and (-) particles, with a net charge of (+1).
c. P^+ = Stable: Proton structure must show evidence of stability.
d. $e^- = (-)$: Ejected particle charge from neutron decay must be (-) (electron) and must be shown to originate from the decay.
e. $e^+ = (+)$: Ejected particle charge from proton to neutron conversion must be (+) (positron) and must be shown to originate from the fusion reaction.
f. Photons and Neutrinos, charges must always be (0)
g. Z-P <-> Z-P: Central proposed z-particle must retain its charge and structure during nucleus interactions and not be affected by fusion or decay.
h. $N^0 \rightarrow P^+ + e^- + \upsilon_e$: Neutron decays into a proton and releases an electron and an electron anti-neutrino. All components of the decay must be shown.
i. $P^+ + \upsilon_e \rightarrow N^0 + e^+$: Proton plus electron anti-neutrino plus energy must produce a neutron and a positron. All components of fusion action must be shown.
j. Charge must be conserved.

Definitions (as per this hypothesis):

- An elementary particle, of positive mass, can have a charge of (+) or (-), *not* (0) since it is a fundamental single particle. (photon thus excluded)
- Testing for all combinations concludes the central massive z-particle is a particle of negative charge (-).

The model: Proton and neutron – Spin and Magnetic Dipole Moment

In the proposed proton, shown in Proton (+) with UP spin, OR

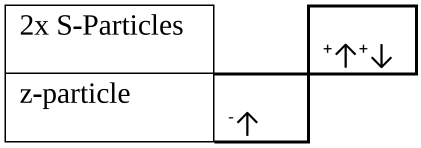
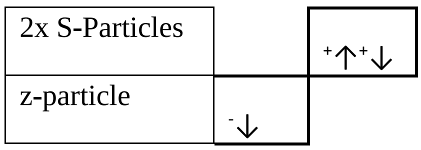


Figure 6, a more massive (-) z-particle and 2 x less massive (+) S-particles make up proton structure. The paired S-particles of opposite spin provides the proton stability. The net spins of the S-particles cancel out to zero, leaving the proton spin=½ in the z-direction accounted for by the (-) z-particle only, which can be up ↑ or down ↓ spin. To a 'spin-observer', a (-) particle with a down ↓ spin would appear like a (+) particle with an up ↑ spin (Figure 6 top) and a (-) particle with an up ↑ spin would appear like a (+) particle with a down ↓ spin (Figure 6 bottom). The composite proton is a (+) particle with ½ spin, meaning it can be up ↑ or down ↓ spin.



Proton (+) with UP spin, OR

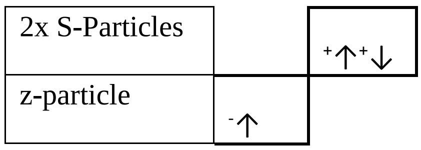


Figure 6: Proton (+) with DOWN spin

Since the net spins of the S-particles cancel out to zero, proton spin = (-1)*spin of z-particle.

Using the mass*MDM = constant premise (see Table 1), the more massive (-) central particle should have shown a smaller spin than that measured in the proton. This indicates the z-particle is itself possibly also a composite of particles with a net (-) charge. For further calculations however, this document uses the proton spin as the z-particle spin, and proposes that the total MDM of the z-particle remains mostly unchanged in nucleus reactions.

In the case of the neutron, shown in Figure 7, except for z-particle (shown only here as down ↓ spin, but can also be in up ↑ spin), all lesser mass particles' spins align parallel in an unstable energized state. (Determined through a process of elimination).

Captured electron			-↑
2S-Particle		+↑	
1S-Particle		+↑	
z-particle	-↓		

Figure 7: Neutron subcomponent spin states = excited state proton with captured electron

The (+) S-particles now have different S_z eigenstates. For the changed (+) 2S-particle, angular momentum has increased by +1 and spin has increased by +1 (from -½ to +½).

An electron has been captured in an outer shell. Neutron total spin is supposedly the sum of all particle spins. However, the neutron spin will still be dominated by the less massive, thus 'larger' (-) captured electron, hence the unusual neutron MDM value of -1.9 U_N.

The neutron is a (0) charge composite particle with ½ spin, meaning it can be up ↑ or down ↓ spin. Figure 7 above portrays only one possibility.

The model: Where is the neutrino

The neutrino was proposed by Pauli in 1930 to explain a lack of observed conservation of energy, momentum and spin[49,52,55]. The neutrino was proposed to be a particle separate from the electron, because the decay did not follow a 2-particle observation. Another anomaly was the fact that the nuclear recoil was not always in the direction opposite the momentum of the electron[53]. Since then, the neutrino has been the focus of many studies[47,48,50,52,55].

The electron ejected from neutron decay[46,55] does not have a discrete energy and does not contain all the lost energy of the neutron decay to proton, as shown below in Figure 8.

Recoil of the proton does not make up for the missing energy. Momentum must be conserved, but the proton is not found to carry away its share of the momentum. With the proton being of a higher mass than the electron, results in it having a lower velocity, therefore less energy, since kinetic energy is linearly proportional to mass but proportional to the square of velocity.

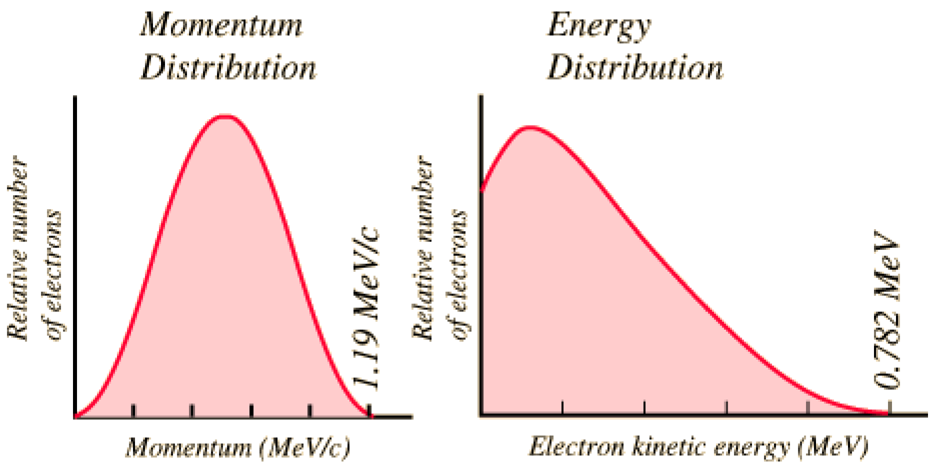


Figure 8: Energy spectrum of beta decay electrons (Image credit: Hyperphysics)

Had these electrons carried all the neutron decay energy, a discrete line of energy would have been detected at 0.782MeV.

[1.293MeV(Neutron decay) = 0.511MeV(electron mass) + 0.782MeV (excess energy)]

However, it is shown there is a high probability that the electron is ejected with zero excess energy (at 0 on x-scale), but more electrons are detected around ~0.1MeV excess energy (graph peak). Many electrons are still detected with more excess energy, and yet an exceedingly small chance exists that the electron would carry away all the decay energy (0.782MeV).

Ignoring momentum energy transferred to nucleus, the anti-neutrino energy for these reactions would be the remainder of the decay energy (0.782 – electron excess energy). The anti-neutrino, then, also has a continuous energy spectrum.

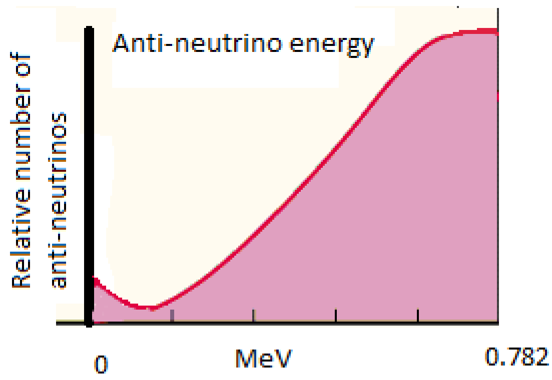


Figure 9: Neutrino energy from neutron decay

Shown in Figure 9, the anti-neutrino has a very small probability of having (almost) zero energy, but most of the times it carries away most of the excess energy. (again, ignoring energy transferred to nucleus for purposes of this comparison)

It is understood that an anti-neutrino rarely interacts with other particles[46,47,48,50,52,55], but Figure 8 shows that the antineutrino 'shares' the excess energy with the ejected (-) particle in a non-discrete manner. Whether the (-) electron starts with all the excess decay energy, or whether the anti-neutrino starts with all the excess decay energy, or whether they each start with some of the excess energy, is not known, but the graphs tend to show that they always interact by sharing the excess energy across a spectrum.

In this model the anti-neutrino will be taken as the packet(s) of energy required to change the orbital and spin-state of one (+) S-particle, and is the energy released again when the S-particle returns to its lower energy orbital and anti-parallel spin state.

The neutrino was proposed as a spin = ½ particle in 1930. Because the proton and neutron are composite particles, this model now proposes the anti-neutrino to be two spin = 1 photons, or possibly a single photon of spin = 2, to simultaneously change the angular momentum and spin of one (+) S particle. These photons add mass to the nucleus when it enters the nucleus and stores its energy by changing the spin of the S-particle, and it subtracts mass when it exits the nucleus, but have no mass while in transit. This would solve the 'neutrino mass' problem.

While the neutrino might react with either of the (+) S-particles, only one final state of particle spins (relative to z-particle spin) allows electron capture. See Figure 7 and also electron capture section below. If no electron is captured, the (neutrino) photon(s) would be (instantly) emitted again, (like an electron passes on incoming photons in glass) thus making matter mostly transparent to the neutrino, unless conditions are ideal for further interaction.

The model: How does the electron get captured?

Spin states of particles with a proton and an electron (hydrogen atom) might look as shown in Figure 10 below:

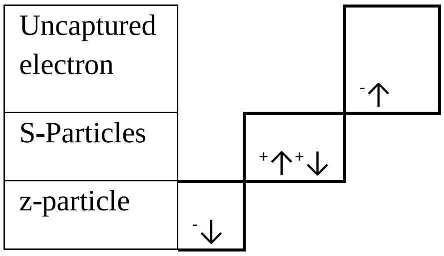


Figure 10: Proton with electron (uncaptured)

The spin of the electron might be ↑, or ↓. Shown here in one state only, antiparallel to the z-particle. The z-particle could also be ↑, or ↓.

Mark Thomson[31]: "Because of the allowed helicity states, the electron and positron interact in a spin state with $S_z=\pm1$, i.e. in a total spin 1 state aligned along the z axis".

It may thus be possible to prevent particle annihilation if spin states are kept favourable. Also, a high energy positron will not annihilate with a low energy electron, until it has been thermalized[56]. The (+ and -) particles in the model are not in the same ground state and annihilation is thus prevented[57].

In Figure 10, the (-) electron is electrostatically attracted to the (+) proton through the Coulomb force. The ↑ (-) electron also wants to interact (annihilate) with one of the (+) S-particles with ↑ spin. However, it is prevented by the other (+) S-particle with ↓ spin and therefore cannot enter the nucleus. The (+) S-particle is also not in the same ground state as the electron and will not annihilate.

Refer again to the neutron in Figure 7, where (+) S-particles and (-) electron spins are all ↑ aligned (parallel). Here is no (+) S-particle with ↓ spin, and the (-) electron is not prevented from entering the nucleus. The (-) electron can be captured. Spins are now favourable for annihilation, but it still will not annihilate because of mass/energy differences that must first be overcome.

By the same argument as above, when the (+) 2S1 ↑ particle in the neutron decays to 1S2 ↓, the electron is immediately repelled from the nucleus; neutron decay.

The model: Proton and neutron – nuclear reactions

The nuclear proton fusion and neutron decay processes are shown in Figure 11 and Figure 12 below in a shell model, with particle spin states. Captured electron is represented as N-:

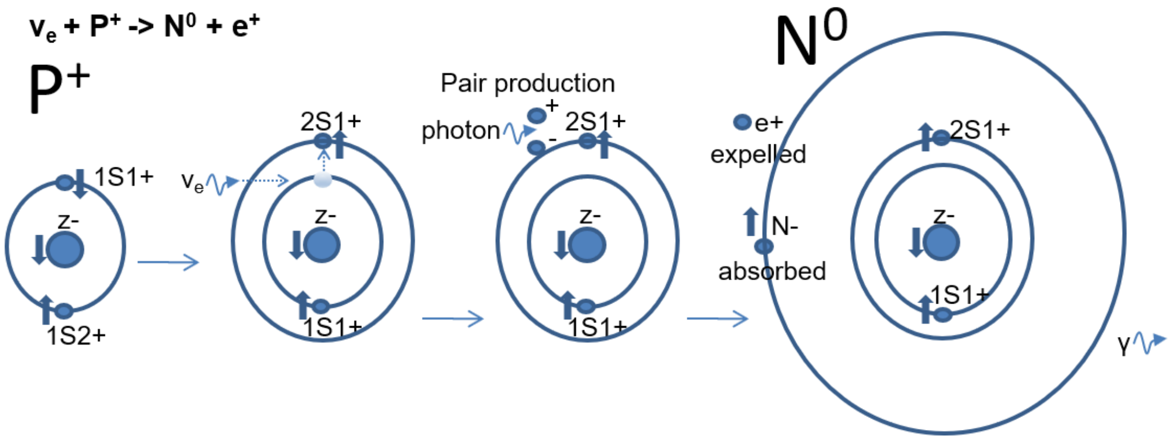


Figure 11: Proton to neutron conversion in shell model, with particle spins

Explanation: Proton is converted to neutron

From Figure 11, $\upsilon_e + P^+ \to N^0 + e^+$: Anti-neutrino plus Proton plus energy produces a neutron and a positron and it is possible to release a photon.

From the left, first image is of a proton. The two anti-parallel spin ↑↓ (+) S-particles offers stability.

Second image shows the 'anti-neutrino' (spin = 2) interacts with the stable proton, delivering energy to one of the two 1S-particles and raising it to aligned spin states into a 2S orbital. The two (+) S-particles now have different S_z eigenstates. Because both (+) S-particles now have ↑ spin, proton is now in a state ready to capture a ↑ spin (-) electron into the nucleus. If an electron is not captured timeously, the ↑ (+) 2S1 particle may return to its ↓ 1S2 orbital and emit photon(s).

Third image from the left: Excess energy is available, or another photon delivers energy. Through pair production, a (+)(-) pair spontaneously appear in the proton, of mass-energy greater than an electron, but less than the S-particles.

Fourth image: From the produced pair, a (-) particle with ↑ spin is captured, and (+) particle is electrostatically repelled. If an (-) energetic electron was captured from the atom itself, no (+) particle will be ejected.

This (ex-proton) is now an unstable particle, with a total 3*(+) particles, and 2*(-). Of the produced pair, an (-) electron has been captured, a (+) positron is ejected, as well as possible photon(s) of excess energy.

A neutron remains. S-particle spins ↑↑ are aligned and unstable, but now prevented from returning to opposite spin by the presence of the ↑ (-) captured electron.

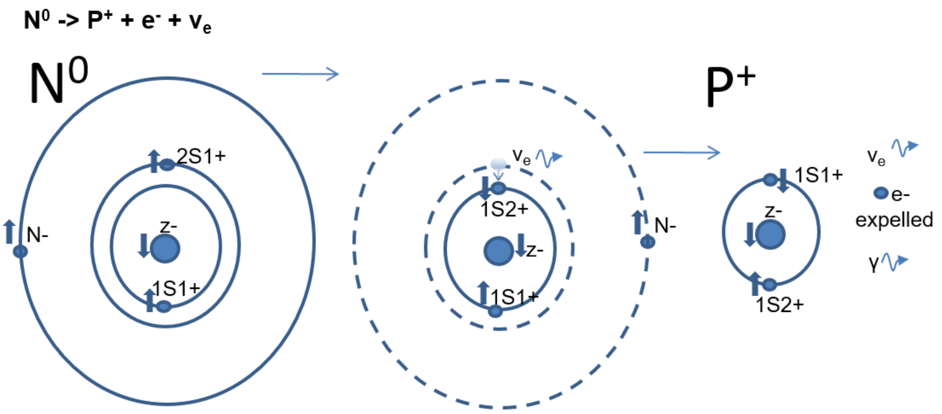


Figure 12: Neutron to proton conversion in shell model, with particle spins

Explanation: Neutron decays to proton

From Figure 12, N^0 -> $P^+ + e^- + \upsilon_e$: Neutron decays into a proton and releases an electron and an electron anti-neutrino.

In the first image from the left in Figure 12 is a neutron. Known to be unstable when not attached.

In the second image in the neutron decay sequence, the spin of the ↑ (+) 2S1 particle wants to settle back into the lower orbital with ↓ spin. However, after the capture of the ↑ (-) electron, the ↑ (+) 2S1-particle now *requires additional energy* to return to its original ↓ spin state. If the ↑ (-) electron (or any other particle, or the environment) has sufficient excess energy to transfer to the ↑ (+) 2S1 particle, to allow it to return to its original ↓ spin state, then ↓ (+) 1S2 and ↑ (-) electron spins will be mis-aligned. The ↑ (-) electron will be ejected, and the (+)2S1 accumulated energy will be released as photon energy (shown in Figure 12 as anti-neutrino). If the ↑ (-) electron, or any other particle, does not provide sufficient excess energy to the ↑ 2S1(+) particle, e.g. when bound to a proton, the neutron will not decay.

The (-) particle might exit relativistic, but the anti-neutrino is photon-like and will probably still interact with it. There is a probability the anti-neutrino will interact with the ejected (-) particle, delivering some (Compton effect), or all (absorbed), of its energy to the (-) particle. This will result in the continuous spectrum of Figure 8.

The anti-neutrino may have lost some, or all, or none of its energy, to the electron, or to the nucleus. The continuous energy distribution of an ejected electron[46] shows that the anti-neutrino interacts more often than currently estimated. (In this model the anti-neutrino is a spin = 2 photon or two spin = 1 photons.)

A proton remains, afterward. S-particle spins are again anti-parallel ↑↓ in the lowest orbital, resulting in a stable proton particle.

The ejected (-) electron may also emit (a) photon(s) as it sheds excess mass-energy.

The model: Proton and neutron – shell model with charges and spin:

See models of proton and neutron in Figure 13 and Figure 14.

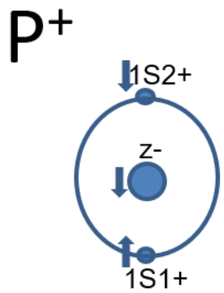


Figure 13: Proton shell-model with particle spins

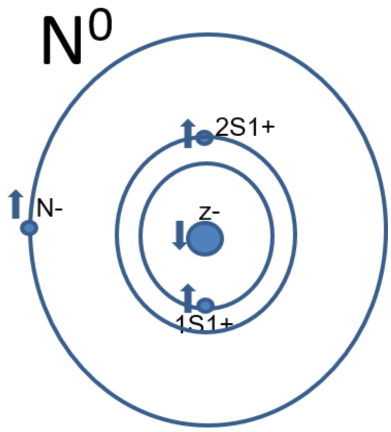


Figure 14: Neutron shell model with particle spins

If the neutron does not fuse with a proton, the N- particle (electron) will eventually be expelled as an energetic electron when the neutron decays to a proton. (See supplementary information to this document for proposed examples of particle interactions.)

Proton and neutron charge distribution

Consider again, in Figure 2 and Figure 3, the observed radial dependence of the charge densities of the proton and neutron, and compare with the shell-models of the proton and neutron in Figure 13 and Figure 14.

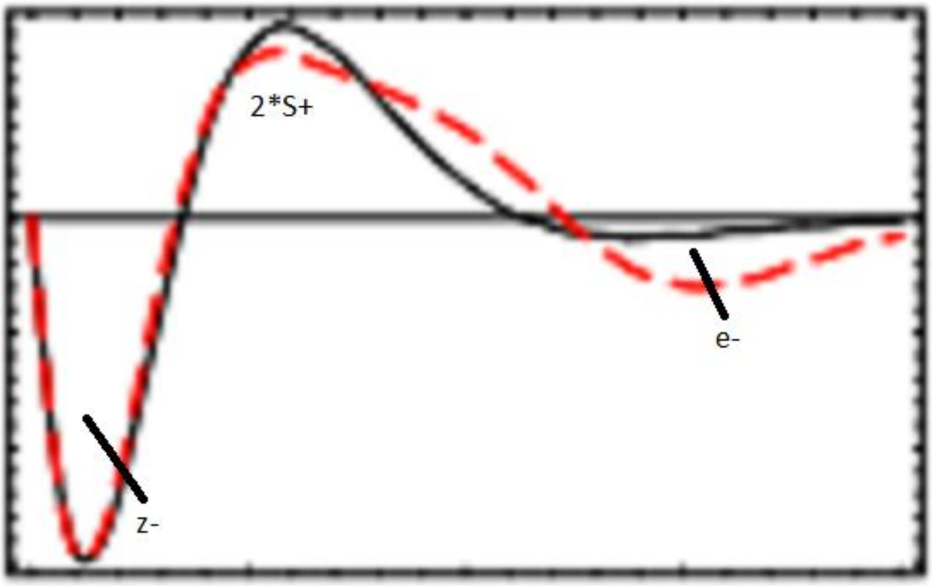


Figure 15: Particles in the charge distribution

Figure 2 shows the peak in (+) charge detection, for both the proton and neutron, toward the centre (but not in the centre), due to the presence of two (+) S-particles.

The (-) electron in the neutron would be the main reason for the observation of a (-) charge shell outside the neutron[34,37,39]. Toward the 'far outside' of the neutron, detection of the equal number of (+) and (-) particles will appear as a zero charge.

A redo of Figure 3, see Figure 15 above, shows the (-) z-particle is responsible for the (-) charge in the centre of the neutron.

Final summary of conclusions

Charge

If a charge *is not* observed in a composite particle, it is because the charges of all fundamental particles in the composite particle are an *equal* number of (+e) and (-e) particles. An example of this is the neutron, or a proton with one electron. The neutron is a combination of charged particles; equal number of (+) and (–).

If a charge *is* observed in a composite particle, it is because the charges of all fundamental particles in the composite are an *unequal* number of (+e) and (-e) particles. An example of this is the proton, or an ion. The proton is a combination of charged particles; one more (+) than (–).

Electrostatic charge e = ±1.6022E-19 Coulomb is a constant property of each single fundamental particle. (±e) is not dependent on the mass or energy of a fundamental particle. Fractional charges do not apply.

Confinement

$E*\lambda = h*c$ as a constant applies to all fundamental particles. The size or mass of an elementary particle could vary without affecting its charge.

A particle can be confined within its own length with a binding energy of $E_c = \frac{9mc^2}{2\pi^2}$

If an elementary particle is bound, and it increases its energy content by absorbing a photon but does not escape from its bound state, and does not release the excess energy, it will reduce in size. Similarly, when an elementary particle reduces its energy by releasing a photon, it must increase in size.

The z-particle of the proton and neutron is a (-) charge particle. Two additional, less massive (+) particles, of opposite spin, make up the proton.

The model

The proposed proton and neutron model passes all the tests of charge assignments and conservation of charge and energy. See Figure 13 and Figure 14.

Pair production around the more massive (-) particles in the proton transforms it into a neutron and ejects a positron. See Figure 11.

Instability has been recognised in the neutron. The spin of the ↑ (+) 2S1 particle wants to return to a lower energy, coinciding with ejection of the (-) electron. See Figure 12. If the N-electron is retained through fusion with a proton, the neutron remains stable.

Additional conclusions

All matter could be born from pair production. All things being equal in the universe, for every (-) particle, a (+) should be present somewhere, either bound or free. Their energies and mass may change, but not their charge.

The ‘missing’ antimatter (+) particles may be confined within the proton and neutron. Assign one electron to each proton, add all the neutrons, then there should be equal numbers of (+) and (-) particles in the entire universe.

Acknowledgments

Ciandri Zinserling (concept discussions and document support), Peter Dormehl (critical analysis), Heinrich Zinserling (model discussions), Carmen Brunette (document support, and for being the centre of my universe)

References

1. Riordan M. The discovery of quarks. SLAC-PUB-5724 [page on the Internet]. 1992 [cited 2015 Sep 2]. Available from: Stanford University, Stanford Linear Accelerator Center, Web site: http://www.slac.stanford.edu/cgi-wrap/getdoc/slac-pub-5724.pdf
2. Gell- Mann M. A schematic model of baryons and mesons. Physics Letters [serial on the Internet]. 1964 [cited 2015 Sep 2].;8(3) Available from: http://hep.caltech.edu/gm/images/quarks.pdf
3. Zweig G, “An SU3 Model for Strong Interaction Symmetry” CERN Report No. TH 412 (Geneva, 1964); and “Fractionally Charged Particles and Sub,” in Symmetries In Elementary Particle Physics (Academic Press, New York, 1965), p. 192.
4. Gell-Mann M, “The Eightfold Way: A Theory of Strong Interaction Symmetry,” Caltech Synchrotron Laboratory Report No. CTSL-20 (1961); Y. Ne’eman, Nucl. Phys. 26, 222 (1961).
5. K.A. Olive et al. (Particle Data Group), Chin. Phys. C, 38, 090001 (2014): http://pdg.lbl.gov/2014/listings/contents_listings.html
6. Bethe H.A. (1938) Energy Production in Stars (Phys review 55)
7. Alkofer R. and Greensite J. (2006) Quark Confinement: The Hard Problem of Hadron Physics. http://arxiv.org/abs/hep-ph/0610365v2
8. Codata. Fundamental physical constants. [page on the Internet]. 2014 [cited 2015 Sep 2]. Available from: http://physics.nist.gov/cgi-bin/cuu/Value?e|search_for=elementary+charge
9. In -- Coulomb (1785a) "Premier mémoire sur l’électricité et le magnétisme," Histoire de l’Académie Royale des Sciences, pages 569-577
10. Millikan, R. A. (1913). "On the Elementary Electric charge and the Avogadro Constant". Phys. Rev. 2 (2): 109–143.
11. Niels Bohr, "On the Constitution of Atoms and Molecules" in Philosophical Magazine 26: 1–25, 476–502, 857–875 (1913).
12. Mehra, 1982, Volume 1, Part 1, p. 330
13. M.; Finn, E.J. (1968) Section 1.6 in Alonso, Fundamental University Physics Volume III: Quantum and Statistical Physics
14. Albert Einstein. On the Electrodynamics of Moving Bodies. Annalen der Physik [serial on the Internet]. 1920 [cited 2015 Sep 2].;322(10) Available from: https://en.wikisource.org/wiki/On_the_Electrodynamics_of_Moving_Bodies_(1920_edition)
15. Cottingham, W. N.; Greenwood, D. A. (2007). An introduction to the standard model of particle physics. Cambridge University Press. p. 1
16. Nave R. Up and down quarks. [page on the Internet]. 2012 [cited 2015 Sep 2]. Available from: Georgia State University, Department of Physics and Astronomy Web site: http://hyperphysics.phy-astr.gsu.edu/hbase/particles/quark.html#c3
17. Ucdavis Chemwiki. Drawing organic structures. [page on the Internet]. 2015 [cited 2015 Sep 2]. Available from: University of California, Web site: http://chemwiki.ucdavis.edu/Organic_Chemistry/Organic_Chemistry_With_a_Biological_Emphasis/Chapter_01%3A_Chapter_1%3A_Introduction_to_organic_structure_and_bonding_I/Section_1.3%3A_Drawing_organic_structures
18. Montgomery J, Jeffery R. A lattice / modified cluster model of the atomic nucleus. [homepage on the Internet]. 2008 [cited 2015 Sep 2]. Available from: http://www.unclear2nuclear.com/

19. International Conference on Color Confinement and Hadrons in Quantum Chromodynamics: The Institute of Physical and Chemical Research (RIKEN), Japan, 21-24 July 2003 Hideo Suganuma, M. Oka
20. J. Beringer et al. (Particle Data Group), Phys. Rev. D86, 010001 (2012)
21. Brian DN (2015) Precise Calculation of the Up and Down Quark Mass Using an Adjusted Compton Wavelength Common Factor Analysis. J Theor Comput Sci 2:125. doi:10.4172/jtco.1000125 Available from: http://dx.doi.org/10.4172/jtco.1000125
22. Schrödinger, E. (1926). "An Undulatory Theory of the Mechanics of Atoms and Molecules". Physical Review 28(6): 1049–1070
23. Nave R. Energy to Confine Particles in a Carbon Atom. [page on the Internet]. 2012 [cited 2015 Sep 2]. Available from: Georgia State University, Department of Physics and Astronomy Web site: http://hyperphysics.phy-astr.gsu.edu/hbase/quantum/carbconfine.html#c1
24. Physics Pages. Hydrogen atom: probability of finding electron inside the nucleus. [page on the Internet]. 2013 [cited 2015 Sep 2]. Available from: http://www.physicspages.com/2013/01/23/hydrogen-atom-probability-of-finding-electron-inside-the-nucleus/
25. Centro De Física Teórica E Computacional. Phenomenology of Supersymmetric Integer Charge Quark Theories. [page on the Internet]. 2015 [cited 2015 Sep 2]. Available from: Universidade de Lisboa, Faculdade de Ciências Web site: http://cftc.cii.fc.ul.pt/investiga.php?id=2
26. Lachapelle J. Quarks with Integer Electric Charge. [page on the Internet]. 2015 [cited 2015 Sep 2]. Available from: http://arxiv.org/abs/hep-ph/0408305v2
27. Iijima B, Jaffe RL. Can quarks have integer charge? Physical Review D [serial on the Internet]. 1981 [cited 2015 Sep 2].;24(177) Available from: http://dx.doi.org/10.1103/PhysRevD.24.177
28. Rajasekaran G, Rindani SD. Integer-Charged Quark Model and Electron-Positron Annihilation into Three Jets. Progress of Theoretical Physics [serial on the Internet]. 1982 [cited 2015 Sep 2].;67(5) Available from: http://ptp.oxfordjournals.org/content/67/5/1505.full.pdf
29. Han MY, Nambu Y. Three-Triplet Model with Double SU(3) Symmetry. Physical Review Letters [serial on the Internet]. 1965 [cited 2015 Sep 2].;139(B1006) Available from: http://journals.aps.org/pr/abstract/10.1103/PhysRev.139.B1006
30. Nave R. Pauli Exclusion Principle. [page on the Internet]. 2012 [cited 2015 Sep 2]. Available from: Georgia State University, Department of Physics and Astronomy Web site: http://hyperphysics.phy-astr.gsu.edu/hbase/pauli.html
31. Thomson M. Electron-Positron Annihilation. [page on the Internet]. 2011 [cited 2015 Sep 2]. Available from: Michaelmas, Web site: http://www.hep.phy.cam.ac.uk/~thomson/partIIIparticles/handouts/Handout_4_2011.pdf
32. Phys.org. 2015 Are scientists finally on the brink of understanding where proton spin comes from? Website: http://phys.org/news/2015-06-scientists-brink-proton.html
33. E. Comay 2010 The Regular Charge-Monopole Theory and Strong Interactions http://www.tau.ac.il/~elicomay/RCMT.pdf
34. Charles Perdrisat and Vina Punjabi (2010) Nucleon Form factors Website: http://www.scholarpedia.org/article/Nucleon_Form_factors
35. A.A. Arkhipov 2001 On global structure of hadronic total cross sections Website: arXiv:hep-ph/9911533v2

36. Randolf Pohl et al 2016 Laser spectroscopy of muonic deuterium. DOI: 10.1126/science.aaf2468
37. Gerald A. Miller 2007 Charge density of the neutron Website: arXiv:0705.2409v3 [nucl-th]
38. Robert Eisberg, Robert Resnick 1985 Quantum Physics 2nd edition
39. Georges Sardin 2001 Fundamentals of the Orbital Conception of Elementary Particles and of their Application to the Neutron and Nuclear Structure Website: arXiv:hep-ph/0102268v2
40. Encyclopaedia Britannica, Gamma Rays, Website: https://www.britannica.com/science/gamma-ray
41. Hyperphysics, Magnetic Dipole Moment, Website: http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/magmom.html
42. Our Quantum World, edited by Ed Lake, Website: https://aeon.co/essays/what-really-happens-in-schrodinger-s-box?utm_source=Aeon+Newsletter&utm_campaign=c238ec4af3-EMAIL_CAMPAIGN_2017_04_18&utm_medium=email&utm_term=0_411a82e59d-c238ec4af3-69538409
43. Christine A. Aidala, Steven D. Bass, Delia Hasch, Gerhard K. Mallot, The spin structure of the nucleon, Website: https://arxiv.org/abs/1209.2803v2
44. Martin A. Faessler, Weinberg Angle and Integer Electric Charges of Quarks, Website: https://arxiv.org/abs/1308.5900v1
45. J. E. Sherwood, T. E. Stephenson, and Seymour Bernstein, Stern-Gerlach Experiment on Polarized Neutrons, DOI: https://doi.org/10.1103/PhysRev.96.1546
46. Hyperphysics, Decay of the neutron, Website: http://hyperphysics.phy-astr.gsu.edu/hbase/Particles/proton.html#c4
47. Dave Casper, What is a neutrino, Website: http://www.ps.uci.edu/~superk/neutrino.html
48. Didier Verkindt, Neutrino History, Website: http://lappweb.in2p3.fr/neutrinos/anhistory.html
49. Didier Verkindt, Pauli's letter of the 4th of December 1930, Website: http://lappweb.in2p3.fr/neutrinos/aplettre.html
50. Luis A. Anchordoqui, 15 Jun 2016, Lectures on Astronomy, Astrophysics, and Cosmology, arXiv:0706.1988v3 [physics.ed-ph]
51. Hyperphysics, Energy and momentum spectra for beta decay, Website: http://hyperphysics.phy-astr.gsu.edu/hbase/Nuclear/beta2.html
52. Neutrinoless Double Beta Decay and the Quest for Majorana Neutrinos, Richard Ruiz , 2015, Website: http://www.quantumdiaries.org/tag/majorana/
53. Hyperphysics, Electron and antineutrino, Website: http://hyperphysics.phy-astr.gsu.edu/hbase/Nuclear/beta.html#c3
54. Robert N. Cherry, Jr., Encyclopaedia of Occupational Health and Safety, Chapter 48, Website: http://www.ilocis.org/documents/chpt48e.htm
55. Susan Cartwright, Neutrinos and Neutrino Oscillations, Website: http://www.hep.shef.ac.uk/cartwright/pubweb/neutrinos_advanced.html#top
56. Essmat Mahmoud Hassan 'Sayed Ahmed, Characterization of Control Mesoporous Glasses (CPGs) Using Positron Annihilation Lifetime Spectroscopy (PALS), Website: http://141.48.10.211/diss-online/08/08H048/t2.pdf
57. Arsalan Torke Ghashghaee, Extragalactic Positrons, Website: http://fse.studenttheses.ub.rug.nl/11140/1/Extragalactic_Positrons.pdf

58. Andrew Pickering, Constructing Quarks A Sociological History Of Particle Physics-University Of Chicago Press (1984)
59. A.J Barr (2009-2013), The quark model and deep inelastic scattering, Website: http://www-pnp.physics.ox.ac.uk/~barra/teaching/hadrons.pdf

Supplementary Information

Where are the other baryons and mesons in this model?

Gell-Mann M. motivated the SU(3) symmetry group by using unitary triplets as fundamental objects. This document differs slightly from this outlook, in that there are still three particles in the proton, only the type of the particles differs. There are no up- and down quarks. Two (+) particles surround the more massive (-) z-particle.

There is little argument here against the ensuing 'particle zoo'. Only that different combinations of (+) and (-) particles are needed to get to the same results. Particles of different mass will briefly interact before annihilating. Before it can annihilate, one particle needs to shed energy so it can be of equal mass and size to its antiparticle. Particle spins will also determine how they interact. A pion, (π^0) for instance, may be a ↑ (+) and a ↓ (-) particle.

All detected particles thus far have shown integer charges. It is then possible to build up the particle zoo from combinations of the particles presented in this document, and all their higher order excited states, with varying spins to individual components allocated. This work is left to future studies.

Sample structure: Helium. Strong bond.

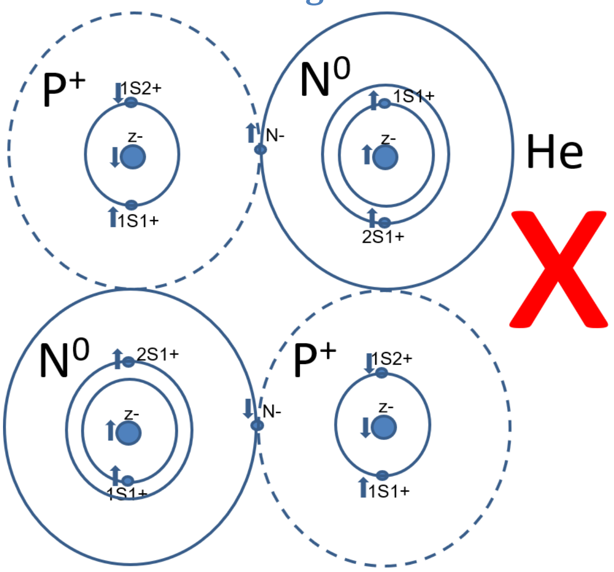


Figure 16: Incorrect Helium structure

Figure 16 shows an example of an incorrect implementation of this model. This may have been an option if helium was (very) weakly bound.

It is proposed that in a strong bond, the z-particles bind form a spin-pair.

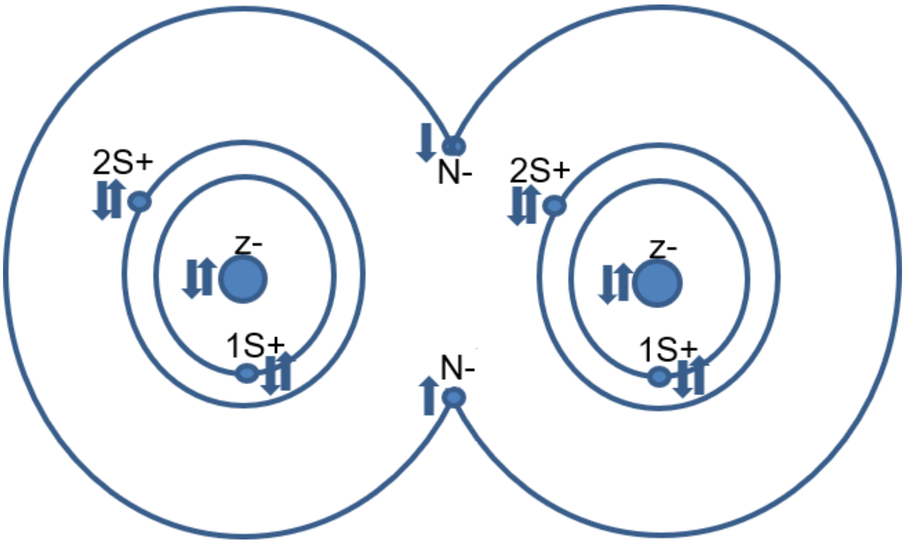


Figure 17: Helium structure?

Proposed (hypothetical) presentation of helium as a strong bond, shown above in Figure 17. Examine the left half of the helium structure above: Proton and neutron have completely fused to form one particle with two z-particles of opposite spin. Since one was proton and one was neutron, there is still only one N-particle (electron) on the left. Combine two of these particles to form the complete helium nucleus. Electrons alone do not make up the binding energy. A lot of the binding energy is in the low energy state of all particles with opposite spin partners. As per Pauli's exclusion principle, the left and right part of the above particle cannot exist in one space, and the helium should have an elongated structure. Like the neutron, helium should appear to have a (-) outer shell to the nucleus.

Captured electron	$^{-}\uparrow^{-}\downarrow$			
S-Particle	$^{+}\uparrow^{+}\downarrow$	$^{+}\uparrow^{+}\downarrow$	$^{+}\uparrow^{+}\downarrow$	$^{+}\uparrow^{+}\downarrow$
z-particle	$^{-}\uparrow^{-}\downarrow$	$^{-}\uparrow^{-}\downarrow$		

Table 3: Helium spin states (total spiu=0)

Helium is now a complete set where all particles are paired with their opposite spin counterpart. No unpaired particles remain, hampering formation of a stable 5-nucleon particle. Fitting two helium particles (8Be) into one stable nucleus is improbable.

Because all particles are now paired with opposite spins, helium is a spin=0 atom, with MDM=0. Net nucleus charge = +2.

Sample structure: Carbon

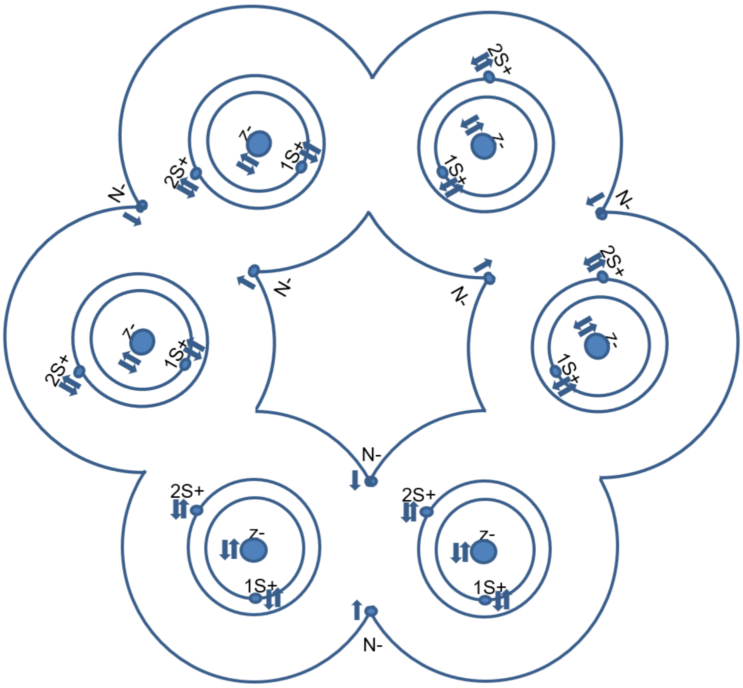


Figure 18: Carbon12?

Figure 18 shows a speculative example of the model to apply structure to higher-order particles. Carbon consists of three bound alpha particles. The carbon atom's typical hexagon shape is seen also in the nucleus shape. N- particles (electrons) are not only shared between proton and neutron, but also between alpha particles. Other binding arrangements are possible, e.g. through S-particles, but have not been fully explored.

Since carbon is built up of three helium (alpha) particles, it is also a spin=0 particle.

Sample structure: Nitrogen

Two fused neutrons, of opposite spin (spin=0), in the centre of ^{12}Carbon would make this into ^{14}Carbon. Because of the surrounding (+) charges, two neutrons can exist (almost) stable in the centre. One of these centre neutrons undergo beta decay (ejects an electron) and ^{14}Nitrogen remains. The central proton and neutron particles are no longer fused but weakly bound, like deuterium. Spin=1. The At this point the 2D model, used so far, no longer suffices.

Neutron and Proton mass

Using the premise of Table 1 that mass * magnetic dipole moment = constant for elementary particles, and because all spins (except z-particle) align, the masses of the particles in the neutron can be estimated. Mass differences between 1S and 2S particle states, in the neutron, are estimated based on beta decay for free neutrons. See section:

The model: Where is the neutrino

In the neutron, all spins add up to neutron magnetic dipole moment (MDM). Table 4 shows for the neutron, estimated masses of individual particles in the nucleus also add up to neutron mass. Excess mass is shown here distributed between the (-) electron and (+) S2-particle , but various isotope decays have different excess energies[51,53]. Typical maximum beta energies range from 18.6 keV for tritium (3H) to 1.71 MeV for phosphorus-32 (32P)[54]. It is anticipated that the excess mass-energy is shared between the (+) 2S1-particle, and the (-) electron in the neutron:

A free neutron decays with 0.782MeV excess energy. An estimated excess mass-energy of 0.1173MeV is assigned to the captured (-) electron (0.5110[electron mass] + 0.1173[excess] = 0.6283MeV), and the balance of free neutron decay to the neutrino, interacting with the (+) S2 particle. Through iteration, masses are determined (NB this is a gross estimate, since binding energies are not accounted for; decimal places shown are not a measure of certainty):

Particle	C	S	Description	Mass (MeV/c²)	MdM (J/T)
(z)	-	↓	z-particle (-)	936.2512	1.41060679E-26
(S1)	+	↑	1S1-particle (+)	1.0105	4.69533361E-24
(S2)	+	↑	2S1-particle (+)	1.6752	2.83224699E-24
e-	-	↑	electron (-)	0.6283	-7.55134905E-24
			TOTALS	**939.565**	**-9.66237849E-27**
(N^0)	**0**	↓	**Compare Neutron (0)**	**939.57**	**-9.66236499E-27**

Table 4: Speculation of neutron sub-particle masses and magnetic dipole moments

The slightly higher negative MDM of the captured (-) electron, compared to the total positive MDM of the two S-particles, maintains a fragile stability in the neutron.

From the calculated (+) S1-particle above, the proton mass can be confirmed.

Particle	C	S	Description	Mass (MeV/c²)	MdM (J/T)
(z)	-	↓	z-particle (-)	936.2512	1.41060679E-26
(S1)	+	↑	1S1-particle (+)	1.0105	4.69533361E-24
(S2)	+	↓	1S2-particle (+)	1.0105	-4.69533361E-24
			TOTALS	**938.272**	**1.41060679E-26**
(P^+)	**+**	↑	**Compare Proton (+)**	**938.272**	**1.41060679E-26**

Table 5: Speculation of proton sub-particle masses and magnetic dipole moments

Tests that could be conducted, and further studies required

The hypotheses in this document seem to answer to many unexplained current observations. That is not proof enough though. Further tests and proofs are needed. This hypothesis disagrees with the current quark model, and thus offers a different perspective. However, this hypothesis agrees poorly with current understanding of neutrinos and needs refinement.

- Find the (+) S-particles. 1S and 2S. Subject a proton to sufficient energy to cause 1S spin ↓ change to 2S spin ↑. Energy released from 2S to 1S transition should be at a discrete energy level, measurable by $\Delta E=hf$, just like an electron orbital change. (barring losses due to collisions with electron or z-). It should thus be possible to excite the proton in a known field of energy, or by bombarding it with other energetic particles.

- Whilst the proton is in an energised state as above, subject the proton to sufficient additional energy to allow spontaneous pair production inside the nucleus. A (-) particle may be captured. The energised proton could also be bombarded with energetic electrons, which may be captured. Proton has been converted to neutron.

- While neutrinos are said to be abundant, and must frequently interact with the 2S particle, protons do not spontaneously capture electrons to convert to neutrons. This is known because neutron decays would be abundant. The neutrino must interact with the S-particles for a neutron to form, but what interacts with the electron and how much? Spin plays a role, but what other condition does the electron have to be in to ensure a higher probability of capture?

- Next step: Understand and control fusion.

- Find the (N-) electron in the neutron. It's an electron, with extra mass-energy.

- Find the (-) z-particle in the proton and neutron, and/or its subcomponents.

- Find 2 x (+) and 1 x (-) charged particles in the proton and find 2 x (+) and 2 x (-) charged particles in the neutron.

- Is the excitation of the (+) S-particle the neutrino? It differs greatly from current neutrino learning. Spin and mass do not agree.

- Where are the W and Z bosons in this model? Where are all the other Standard Model particles? Neutrino oscillation is not well explained by this model, and neither are any of the other generations of particles. Extend this model to find more common ground with the Standard Model.

- Repeat the exact experiment of Charles Perdrisat and Vina Punjabi (2010) and Miller 2007, but at increments to higher energies. Higher energies should detect the (-) z-particle more often, and the resultant charge inside the neutron (and proton) could be confirmed negative. Here could also be determined if the z-particle is a shell of underlying (+)(-) particles. The model here-in was tested against only a few requirements involving charge, proton fusion, and neutron decay. These tests only required the presence of the z-particle, and 2 x (+) S-particles. There may be higher order shells (see Figure 13) inside the z-particle of both the proton and the neutron, as long as the net charges of these additional shells add up to zero. Detecting more massive particles in the proton or neutron will affect this model and is important to know.

- With all spins aligned in the neutron (except z-particle), neutron decay may be prolonged if kept in a strong enough magnetic field. 2S+ cannot return to 1S+ unless it changes its spin first. A correct magnetic field may inhibit the change of 2S+ to 1S+ and prolong neutron life.