Hadron and quark masses and magnetic moments in a pre-fermion framework

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This paper shows how QCD can be reinterpreted by a pre-fermion hypothesis as a system of aligned stacks of loops, each formed from pairs of only one type of particle and anti-particle. The hypothesis is of only one fundamental particle, the meon, and its anti-particle which, in pairs, form the only stable composite structures as matter, anti-matter and dark matter loops. The loops travel either through the myriad of originally partially merged meon/anti-meon pairs, which have the effect of viscosity – producing a maximum velocity for any meons – or through tunnels from which the partially merged pairs are excluded, travel through which does not suffer viscosity and sets no maximum velocity. The former is the relativistic environment and the latter is the quantum environment, implying that the two environments are mutually exclusive and their equations of motion cannot be reconciled. The hypothesis shows, by reinterpreting definitions, that matter and anti-matter are equally prevalent everywhere and that physics does not break down anywhere. Also the hypothesis perfects the SI system of units to show that all properties have maximal values of powers of $\sqrt{c}$ and $\sqrt{\hbar}$ or additionally $\sqrt{\alpha/2\pi}$. The hypothetical framework is used here to model the masses and magnetic moments of the quarks to estimate the masses of the mesons and the masses and magnetic moments of some baryons using the same quark masses throughout – unlike the main Quark Model – with resultant better overall accuracy.

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I. INTRODUCTION

Quantum Chromodynamics (QCD) is the theory of strong interactions between quarks and within hadrons [1]. QCD splits the treatment of the physics and mathematics of hadron mass and magnetic moment composition into two separate realms – high energy and low energy – respectively relativistic versus treatable using perturbation theory. Although this is mathematically appropriate, it fails to address the actual underlying physical structure of the hadrons and interprets some aspects incorrectly.

The current Quark Model interpretation is of either free moving or strongly bound quarks [2]. The estimated two smallest quark masses in each interpretation are substantially different, being in the range 5 MeV/c^2 or 300 MeV/c^2 respectively [3]. In the latter case, the masses used in the Quark Model to replicate the effects observed differ depending on whether the calculation is designed to replicate either the hadron masses or their magnetic moments.

The current treatments are therefore not self-consistent.

The experimental results [4] that show that the valence quark component of hadron spin represents only a minor fraction of the total spin energy has led to the theoretical introduction of gluons within hadrons, as vector boson colour force carriers [5]. Similarly, the quark momenta indicate [6] that their masses amount to a minor fraction of the hadron total mass.

It is also surprising that, having concentrated on motional energies to the exclusion of potential energies in one of the bibles of QM [7], the treatment is then segued immediately into using those energies as effectively potential energies – as if hadrons consisted of stably orbiting free quarks.

The 'pion cloud' or 'meson cloud' [8] model appears to be the current mostly likely accepted candidate for the physical makeup of hadrons, but has drawbacks that may be improved by the pre-fermion hypothesis (PFH) outlined here and with more detail in previous papers [9, 10, 11].

This paper is written as if everything hypothesized is correct and does not cover issues, and definitions, that the previously referenced papers treat appropriately, such as Double-adjusted SI units (DASI), meons, partially merged/unmerged meon pairs, the background, dimensionality, zerons, loop structures and loop stacks.

Where a quark, meson or baryon is named in the paper, its anti-particle is also implied where appropriate, but be aware that, as explained later, the definition in the hypothesis of which is a particle and which an anti-particle is different to current terminology.

In the PFH, nothing is created or destroyed. Everything already exists, even if directly unobservable as partially or completely merged meon pairs and zerons, all of which comprise part of the background which is the fabric of the universe through which all relativistic motion of unmerged meon pairs in loops occurs. All unmerged meon pairs are always in motion, and the result of a matter loop interacting with an anti-matter loop is the combination of the two, usually as a photon, not annihilation.

II. SIGNIFICANCE and OBJECTIVES

The significance of the new PFH interpretation is that it shows that hadrons can be considered more like standardised aligned composites whose components are themselves standardised. The low and high energy current interpretations become instead explainable as examples of shielded and separated components, respectively.

The redefinition of matter and anti-matter implies that there is no matter/anti-matter imbalance in the universe and offers possible insights into such areas as CP violation in kaons and other mesons.

The objective is to produce an explanation that is simple and yet provides an accurate estimate and explanation for the masses and magnetic moments of some of the mesons and baryons.

III. EXPLANATION

The current main idea that comes closest to the PFH and which is supported by data [12] is that of the 'pion cloud' or 'meson cloud' [13] surrounding the quarks. However that uses gluons as force carriers, with their colour force attributes, the two differently treated energy regimes and renormalisation of masses and coupling constants, through energy cut offs or required by the presumption of point-sized unaligned particles, across different observational energies.

The biggest difference in interpretation is that in QED/QCD charge forces are assumed to be due to electromagnetic, strong nuclear or quark colour forces, whereas in the PFH there are only two forces in action, due to the mass and charge energies of the fundamental meon/anti-meon particles in various guises. Those forces are due to the fundamental energies that the meons have and are transmitted either directly between meons – when inside loops and stacks at short separations – or indirectly from loop to loop, or loop to the background and vice versa, at greater separations, by partially merged meon pairs within the background. It is the mass and charge energies of motion of the meons that produces spin, one-sixth electron charges, magnetic moments and the effect of mass and gravitation.

The PFH proposes that instead of being unaligned quarks with a meson cloud, the hadrons are instead mainly aligned stacks of loops. Those loops are the valance quarks and aligned leptons, either singularly or in pairs, as π^+ , π^0 or 'small' variants of ρ^+ , ρ^0 mesons, and photons with unaligned contributions from the background, where zerons – double-loop leptonic zero spin rho mesons or their photon-equivalents - pre-existing and centred at all points in space, and at all energies – and partially merged meon pairs, exist .

The loops in a stack need to be aligned, otherwise the valence loops (spin ± ½), mesons (spin ±1) and photons (spin ±1) would not necessarily produce stacks with total spin ±*n*½. The idea that gluon or meson clouds somehow always manage to achieve total spin ±*n*½ is not sustainable.

The loops are presumed to have specific sizes that do not change, other than as a result of their own relativistic motion. Therefore the mass and magnetic moments of the aligned stack of loops that comprise a hadron are purely the sum of the properties of those loops present, adjusted for potential energy, spin and background effects.

In the same way that the hypothesis denies the interpretation of photons as carriers of the electromagnetic force, it also proposes that the pions do not transmit the strong force and gluons do not transmit colour forces. The only force carriers are the partially merged meon pairs [14] which exist as part of the background through which all relativistic motion occurs.

Attached to every meon/anti-meon in every loop there are additional chains of overlapping partially merged meon pairs present and rotating with them. The meon and anti-meon pairs are the fundamental building blocks of all loops, and the symmetry of loops is built around the positions and signs of twist-generated $\pm q/6$ charge, as explained below, within the loops composed of the meons and anti-meons.

The effect of those chains sweeping through the background is proportional to the rotational frequency and total charge of the loop, affecting the length, number and the strength of the chains. The density of the background depends on the density of matter present at any point, which affects how the chains attached to the meons in the loops interact with it.

This means that lines of magnetic field are real – they are chains of partially merged meon pairs between magnetic source and sink. Photons transmit rotational frequency between loops, not forces, in order to maintain them at the size they were left at after inflation. If photons, or any other loop-based particles, were force carriers, they would not be able to transfer forces between individual meons, and so no structures would be able to be formed. The force carriers need to be acting between meons, whether merged or unmerged, with their effect being emergent as an overall action of loops on the background, or vice versa.

Virtual photons 'inside' hadrons are real since, as fully threefold symmetric double loops, they can interact with the hadron stack by being captured by the stack (absorbed) or dislodged from the stack (emitted). Pions and rho mesons are double loops present in loop stacks, providing mass, spin, charge and magnetic moments to the hadrons.

Gluons [15] are here reinterpreted as 'small' double-loops, comprising lepton or quark loop pairs, pions and 'small' rho mesons which all shield the valance quarks, and also provide mass, spin, charge and magnetic moments to the hadrons. The Higgs boson is just a boson. The effect of the chains attached to the loops, as they sweep through the background is to provide the effect described as gravitation. This is a product of the meon rotation that constitutes the loops, not directly of the meon masses within the loops, except at very small loop to loop separations.

At very small distances between loops, the effects of the meons in one loop directly affect the meons in other loops. Since the gravitational constant G can be eliminated from all equations, the strength of mass and charge fields is the same when the strengths of the sources of those fields are the same. It is only the large difference between the locked-in rotational frequencies of the lepton and quark loops, which, together with their relative charge sizes, produce the gravitational effect, and the size of the fine structure constant, which produces the charge field and is proportional to the meon fundamental mass and charge size, due to meon twisting, that makes the two strengths appear to be very different.

Within loops, the meons are at the adjusted-Planck size for fundamental mass and charge, adjusted for relativity and twist/charge energies, and so have very large effects at very small loop-loop separations. These, together with loop charge asymmetries, are what produce the forces that are ascribed to the strong or colour forces.

What is called the colour force is actually not a force, but is the effect of the asymmetry of the positions and signs around the loop, of the twist-generated one-sixth electron charges on the meons. In our matter loops, there are three meon/anti-meon pairs present, both of each pair producing either positive or negative one-sixth the electron charge.

When the loop total charges are not 1 or zero, the positions of the one-sixth charges have either threefold or two fold asymmetry. These loops are the quarks. When the total charges are 1 or zero, the positions of the one-sixth charges around the loop also have a basic threefold or twofold asymmetry. But when these threefold asymmetric loops have three sets of the same, each offset symmetrically, this makes those loops completely symmetric. The zero charge twofold asymmetric loops are asymmetric neutrinos whilst the threefold symmetric loops are the charged leptons and symmetric neutrinos.

Because the symmetric neutrinos are so symmetric, their rotation by 60^0 turns them effectively into anti-neutrinos. So identifying which is a neutrino and which an anti-neutrino is very difficult. There are also two different variants of the symmetric neutrino, either with all meons/anti-meons in the loop twisting to reduce their own charge and mass energies by $\pm|q|c^3/6$ or $\mp|s|c^2/6$, respectively, used to spin the meons about their own axis of revolution ('twist energy'), where q is the electron charge and s its mass equivalent, or increase those energies by those amounts. This produces two slightly different rotational radii and the variations are the same across all neutrino families. So overall, including the twofold asymmetric neutrinos, these three variants treble the number of types within each neutrino family.

Because the hadrons' stack loops are centred along one axis – the centre of rotation of the loops, so that all the loop planes of rotation are aligned parallel - the relative planar angles of those loop asymmetries need to be balanced along the stack in order for the stack to be stable. The stack also needs to have a total charge of 1 or zero in order to exist independently within the local environment. So it is physical rotational charge asymmetry of loops that underlies the colour 'force', only allowing stacks with overall balanced asymmetries (colourless) to exist for any length of time.

The symmetric loops can also exist within threefold asymmetric stacks because they add no asymmetries to the stack and, in balanced threefold asymmetric stacks, the completely symmetric loops have those loops' threefold symmetries. The possible loop total charges for three-pair loops take values of only 0, ±1/3, ±2/3 and ±1 times the electron charge. Loops of other pair numbers are dark matter and for symmetry reasons cannot form stacks with our threefold asymmetric loops.

IV. STACK COMPONENTS

The same underlying partially merged meon pair force carriers are at work as all forces. What are currently interpreted as force carriers are just bosons that can exist because they are appropriately balanced short stacks.

The mix of particles that exist in and around a hadron stack consist of

- The aligned valance quark loops, as charge carriers, providing some mass and spin energies, with attached chains, requiring balance

- The aligned meson loops in the stack – charged or uncharged and with or without spin, normal mass size or at a specific smaller mass, with attached chains
- Aligned photons, adding frequency – either temporarily to top up a loop in the stack, or permanently as additional stack mass – with attached chains
- The unaligned background partially merged meon pairs transmitting all forces
- Unaligned background zerons that underlie pair creation and which can be turned from lepton pairs into quark pairs, the latter forming 'sea quarks', with attached chains
- Unaligned photons, either externally incoming or outgoing or within the hadron as real 'virtual' photons, with attached chains

As mentioned, the mesons are not force carriers, just two stacked loops whose total properties are appropriate enough to enable them to be stable for longer than loops whose total properties are inappropriate. They may be considered as necessary as an intermediate step in the transformation from some initial loops, before interaction, to the resulting loops, after interaction, but they are not strictly required. Loops can break and reform whilst retaining each component meon's properties and the overall sum of the loops' properties, without an intermediate stage.

However, the nearby presence of other loops, which do not take part directly in the interaction, may be needed for the charge and mass fields that they produce to better enable the initial loops to break into chains, and reform as different loops, as part of any intermediate stage.

In stacks, some of the stack loops will remain with the valence quark loops, acting as their shields against the local environment. Some of the stack loops are independent and can be dislodged. Those loops dislodged will be observed, but those not dislodged will contribute to the 'high' energy quark mass interpretation, and are the shielding mesons, here called stack π_s, which could be interpreted as gluons, although some will have zero spin.

The PFH proposes that the reason why there appears to be two different outcomes at the two different interaction energies is because of the success or failure of the shielding of the valence quarks by the different mesons in the hadron stack. The valance quarks cannot exist on their own because they are asymmetric, so require shielding from the local environment. The stack π_s that mainly provide the shielding are either spin 1 or 0 double loops and may be photon-like, composed of positive and negative charged leptons, lepton-like, composed of either a charged lepton and an uncharged lepton or two uncharged leptons, or quark-like, composed of quarks which could have been the result of breaking and then reforming lepton loops. In each case, the stack π_s composite loops are of lower rotational rate, that is lower energy ('smaller'), than when free, and are always the same size. The independent mesons in the stack will have their normal masses and are not stacks π_s loops.

Whether all the stack mesons, including π_s, continue to shield the valence quarks depends on the energy of an interaction. In the estimated mass and magnetic moment calculations, the presumption is that, at least initially, each quark keeps its independent and shielding mesons and therefore that combination is what is used for the calculations.

The two energy extremes of hadron interactions occur either when a high energy particle hits a hadron stack and the shielding mesons are impacted out of the way, or when a low energy particle hits the stack and cannot penetrate through the shielding to reach one of the valence quarks in the stack.

In the former case, it appears that the quark is free within the hadron, with its own mass only, whilst the latter case is as if the whole stack of quark plus shielding stack mesons acts as one composite mass. It may also be the case that each valance quark shares shielding mesons within the hadron stack, so that consistent mass observation results are not possible, especially for the larger mass valence quark components in stacks.

The mathematics of the two extremes of interaction in the Quark Model [16] may be correct, but the interpretation of the physical system, as being the valence quarks themselves with either a higher or lower energy, is not correct in this pre-fermion hypothesis.

The quark masses do not alter, other than their own relativistic effect. It is the sum of shielding plus valence quark masses that looks like a high energy quark. The combined interpretation is that the combination of gluon (shielding mesons) plus quark is a high (mass) energy quark and the separation into separate lower (mass) energy quark and gluon (shielding mesons) represents a reduction in the quark energy. This is the energy equivalent of the Quark Model interpretation [17] of a high energy quark emitting a gluon to lose energy – but the gluons reinterpreted here are the shielding mesons and they are separated, not emitted from 'within' the quark, being always existing both before and after the interaction.

Considering the missing mass and spin components, not due to the valence quarks - since loop mass energy (mc^2)

and loop spin energy (½ *hw*) are equal in size but opposite in type, the two missing components may be thought to be linked. However, the π^+ , π^0 and some π_s components with no spin, but with mass, or vice versa, make the direct linkage difficult.

There is no need for gluons as massless bosons separately from photons, since there is no colour force – only loop asymmetry that needs to be balanced – and so a photon, not being a force carrier, could be the ninth gluon, except that gluons are not required. Photons can stack alongside any stack π_s loops, increasing the ‘mass’ of the loop either temporarily whilst stacked or permanently by passing frequency to one of the loops in the stack. It is the properties of the meons within the loops that are always conserved and the meons can swap between loops to alter the balances of the loops – but always maintaining overall balance in a stack if the stack was previously balanced.

V. MODELLING LOOPS AND HADRONS

Where the paper discusses charged leptons, any of the electron, muon or tau loops, or their anti-loops, may be implied, with the same for neutrino/anti-neutrino or quark families. All hadrons are considered to be at their ground state and only the longest lived of each particle is considered. For magnetic moments, only the baryons with observed magnetic moments are modelled, and each loop is treated as having $g_{spin} = 2$. This is the same as for the electron, since the single loop energy, the loop’s mass, is usually considered to be $E = (½h)w$ but is actually $E = h\,(½\,w)$.

This means that a single loop currently considered to be spin ±½ *h* and frequency *w* is actually spin ±1*h* and frequency *w*/2. The energy of the loop is unchanged because the radius of meon rotation is altered proportionately so that $v = rw$ and $h = mvr$ is still the case, at the new *v*, *r* and *w*, for any loop.

One of the principle assumptions of the PFH is that, at all times, every mass-type energy in a system always has an equal and opposite charge-type energy. In most circumstances the two energies or their derivative forms, being opposite in type, will have different actions (same mass sign attracting - same charge sign repelling), and in some circumstances they will have the same direction of action, such as the centrifugal kinetic energy of each in an orbital system, acting radially outwards.

The following equations relate to the twist-generated mass-energy and its opposite charge-energy, denoted sc^2 and qc^3 respectively, where $q = \sqrt{\alpha/2\pi}Q_*$ and $s = \sqrt{\alpha/2\pi}M_*$, and to the fundamental meon mass and charge energies M_*c^2 and Q_*c^3 respectively, where $M_*{=}Q_*c$ and $M_*{=}\sqrt{hc}$, all in DASI units.

Each meon generates one-sixth of these energies when it twists, the mass one being the energy of the meon spinning about its own axis and the charge one being due to the brushing of the meon surface area against the background – resulting in an observable charge of one-sixth the electron charge, positive or negative depending on the spiral/helical direction of travel and identity of the meon.

Meons are neither fermions or bosons since it is only loops composed of meons and anti-meon pairs that have the properties of spin.

VI. LOOP ENERGIES

For the meon fundamental energies within a non-rotating and stationary (non-translating) loop, the mass and charge equations, remembering that mass and charge are of opposite type, are:

$$E_M = \pm M_* c^2 \quad \text{and} \quad E_Q = \pm Q_* c^3$$

For the meon energies of motion within a stationary loop after they have started spinning (twisting) and travelling at $v/c = \sqrt{(1 - 1/\gamma^2)}$ around the loop, the mass and charge equations are:

$$E_M = (\pm M_* \pm s/6)(\gamma^2 - 1)c^2$$

and

$$E_Q = (\pm Q_* \mp q/6)(\gamma^2 - 1)c^3$$

Loops will have $sc^2/6$ and $qc^3/6$ energy values summed over the loop and that total will be between $0sc^2$ and $0qc^3$ up to $\pm 6sc^2/6$ and $\pm 6qc^3/6$, representing the lepton and quark range of values in a three-pair loop. Note that the numbers of $sc^2/6$ and $qc^3/6$ energies are always the same in any loop.

The mass twist energy is internalised because it represents the spinning of the meons, whilst the charge twist energy is externalised as the observable charge of the loop and its magnetic moment. That one is internal and the other external does not alter that the two are always of equal size.

All unmerged moving meons and anti-meons have twist energies, even though the loop may have those energies sum to zero.

For any loop, the mass angular momentum of all of the meons in the loop is maintained at Planck’s constant *h* by the meons and anti-meons rotating at slightly different radii. This means that their rotational frequency *w*/2 is the same and that they all have the same size of mass motional energy, at low loop rotational frequencies, of

$$E_{ML} = \pm\tfrac{1}{2}(\pm M_* \pm\ s/6)v^2_{+/-} = \pm\tfrac{1}{2}hw$$

since

$$h_A = (+M_* +\ s/6)v_- r_-$$

$$h_B = (+M_* -\ s/6)v_+ r_+$$

$$h_C = (-M_* -\ s/6)v_- r_-$$

$$h_D = (-M_* +\ s/6)v_+ r_+$$

and

$$v_+/r_+ = v_-/r_- = w$$

Note that the individual meons, without twist, would each have motional energy of

$$E_{MNT} = \pm M_*(\gamma^2 - 1)c^2 = \pm\tfrac{1}{2}hw$$

which is the same as their total when twisting – the change in rotational radii produces that realignment. This size $\frac{1}{2}hw$ is also the same as the mass angular momentum of each meon rotating with $\pm h$ and at loop frequency *w*/2, as mentioned.

The outcome is that the larger sized masses rotate at slightly smaller radii than the smaller masses which enables the relative velocities and radii to be calculated.

That the positive meons $+M_*$ have +*h* angular momentum and the negative meons $-M_*$ have –*h* is not an issue. Although the total $\pm M_* c^2\ \pm sc^2/6$ energies, or momenta, always sum to zero over a loop, the meons still chase anti-meons around the loop, and vice versa, which produces, via the attached chains, the effect of gravitation on the background at ½ *hw* as the loop mass energy mc^2, at low rotational frequencies.

The fundamental Q_* charges, which sum to zero over all loops, and the *q*/6 charges which do not except in neutrinos, have charge energies at low rotational frequencies, of

$$E_{QL} = \tfrac{1}{2}(\pm Q_* \mp\ q/6)cv^2_{+/-}$$

where

$$h = Q_* cvr = M_* vr$$

However, the charge energy equation cannot simply be split into two parts at a loop level, as E_{ML} effectively was. So each meon type needs to be considered separately as part of the specific loop being examined in order to calculate the charge and mass momenta and energies.

In the same way as for the meon mass angular momenta, their charge angular momenta can be split into the two different rotational radii

$$\mu_A = (+Q_* -\ q/6)v_- r_-$$

$$\mu_B = (+Q_* +\ q/6)v_+ r_+$$

$$\mu_C = (-Q_* +\ q/6)v_- r_-$$

$$\mu_D = (-Q_* -\ q/6)v_+ r_+$$

It is these two different meon magnetic moment sizes and signs that produce the apparent energy difference between mass and charge energies in a loop.

To simplify the equations, the substitution will be made that

$$j = s/(6M_*) = q/(6Q_*)$$

so that

$$(\pm Q_* \mp q/6) = Q_*(\pm 1 \mp j)$$

and

$$(\pm M_* \pm s/6) = M_*(\pm 1 \pm j)$$

with

$$v_+ r_+ = vr/(1-j) \qquad \text{and} \qquad v_- r_- = vr/(1+j)$$

Now the meon and anti-meon mass and charge momentum properties can be shown over the two radii as

$$\pm\mu_A = (+1 -\ j)Q_* vr/(1+j)$$

$$\pm\mu_B = (+1 +\ j)Q_* vr/(1-j)$$

$$\pm\mu_C = (-1 +\ j)Q_* vr/(1+j)$$

$$\pm\mu_D = (-1 -\ j)Q_* vr/(1-j)$$

$$h_A = M_* vr = -h_C$$

$$h_B = M_* vr = -h_D$$

Splitting the electron mass angular momenta into the main M_* and *s*/6 components separately means using three h_A meons and three h_D anti-meons. For the three pairs present

$$h_{eM} = 3M_* v_- r_- + 3(-M_*)v_+ r_+$$

$$= 3M_* vr[1/(1+j) - 1/(1-j)]$$

$$= -6M_* vrj/(1-j^2)$$

$$= -6M_* vrj/(1-j^2)$$

$$= -svr/(1-j^2)$$

This is the same for all loops and is part of what drives meons around the loop. However, as shown below for the electron, it is balanced by the same size, but opposite, energy due to the *s*/6 twist energies.

The separate meon Q_* charge momentum for the electron would be the same, in *q* terms adjusted for charge sign, using the same meon types as

$$\mu_{eQ} = 3(-1-j)Q_*vr/(1-j) + 3(1-j)Q_*vr/(1+j)$$

$$= 3Q_*vr[(-1-j)/(1-j) + (1-j)/(1+j)]$$

$$= -6Q_*vrj/(1-j^2)$$

$$= -qvr/(1-j^2)$$

It is important to note that this is not the standard definition of the magnetic moment of the electron because the generators of the magnetic moments are the meon masses, not the loop 'mass'. The latter is observable whereas the former is not.

This magnetic moment is too small to observe at large separations from the loop since it has the large meon mass M_* in its denominator, rather than the loop 'mass' ½ *hw*, which is due to the attached chains rotating with the meons in the loop.

Now considering the *q* and *s* twist-generated components in the electron in turn, the mass angular momentum of the *s*/6 is

$$h_{es} = +3M_*jv_-r_- + 3M_*jv_+r_+$$

$$= +6M_*vrj/(1-j^2)$$

$$= +svr/(1-j^2)$$

This is exactly the same size angular momentum as the M_* component, but of opposite sign. The total mass angular momentum of the meons is the same as if they did not have any twisting, but the split shows that the meons have increased their twist angular momenta at the expense of the fundamental angular momentum. Effectively the meons have absorbed the twist energy by adjusting their rotational radii in order to retain the same total angular momentum.

In the case of the twist generated *q* charge momentum, for the same meon types, this is

$$\mu_{eq} = -3jQ_*vr/(1+j) - 3jQ_*vr/(1-j)$$

$$= -6Q_*vrj/(1-j^2)$$

$$= -qvr/(1-j^2)$$

This shows that the Q_* and *q* charges each equally add to the magnetic moment of the electron loop.

This can be seen by calculating either the Q_* and *q*/6 components together or simply summing them to produce

$$\mu_{eqQ} = -12jvr/(1-j^2)$$

$$= -2qvr/(1-j^2)$$

The value of the j^2 factor in the denominator is the very small amount $\alpha/(72\pi)$ which is much smaller than the anomalous magnetic moment and again the whole is based on M_* not the electron mass m_e . This total amount is m_e/M_* smaller than the usual μ_e value.

If the loop above had been, for example, a down quark, the 6 above would have been 2 instead, because the mix of meon and anti-meon momenta would have been different.

The two M_* and *s*/6 angular momentum components, as mentioned, sum to zero. However, the meons still chase around the loop.

The 'missing' angular momentum, or energy, due to the rotating charges when compared with the rotating masses is found in the change in the mass and charge potential energies of the meons as they no longer rotate at their no-twist radius and velocity and have formed a loop from a straight chain.

The potential energy is for both mass and charge, but is complex to calculate because there is no source of mass or charge fields at the centre of the loops and all the meons in a loop contribute to the potential energy.

This energy change will be the same size and opposite to the motional energies of the loop and can be considered as a structural energy that has been used to form the loop from a chain.

The changes in radii can be calculated from

$v_+r_+ = vr/(1-j)$ and $v_-r_- = vr/(1+j)$

such that

$wr_+^2 = wr^2/(1-j)$ and $wr_-^2 = wr^2/(1+j)$

so that

$r^2/r_+^2 = (1-j)$ and $r^2/r_-^2 = (1+j)$

so that

$$r_-^2/r_+^2 = (1-j)/(1+j)$$

The ratio $D_{\mu/m}$ between the magnetic moment energy based on M_* and the mass energy of a loop can be produced from

$$E_\mu = \mu_{eqQ} c(w/2)$$

$$= \mu_{eqQ} B$$

$$= -2qvrc(w/2)/(1-j^2)$$

so that

$$D_{\mu/m} = E_\mu/\tfrac{1}{2}hw = -2q/[Q_*(1-j^2)]$$

$$= -\sqrt{2\pi\alpha}/(\pi - \alpha/72)$$

for the electron. The twist-generation of q in total affects the externalised charge and the consistent h mass angular momentum size similarly affects the Q_* charge magnetic moments.

It is only when considering the loop as a whole, rather than as its constituent meons, that the standard magnetic moment of the electron loop is arrived at. The net charge rotating is the sum of the twist-generated q/6 charges, but it is the observable mass of the loop, the size of the motional kinetic energy of the meons rather than their masses, that is presented in the denominator, thus

$$E_{\mu e} = -qchw/[m_e(1-j^2)]$$

$$= 2\mu_e cw/(1-j^2)$$

It is the externalisation of the twist-generated charges that leads to electromagnetism, but the non-existence, due to internalisation, of any mass-type equivalent. As explained above, it is the case that for each energy type present, there is an equal and opposite type, even if those energies are not externalised.

One aspect of the balance of energies is in the motion, orientation and effect of partially merged meon pairs. Although these pairs are a meon and anti-meon partially merged, whose properties sum to zero, they represent a major part of the fabric of the universe and exist as a myriad of overlapping partially merged meon pairs.

This myriad is very much like a very weak dielectric soup or gravitational aether, where motion through the background is opposed by the electromagnetic viscosity. Each merged meon pair will align like a bar magnet in an external magnetic field and will produce a screening effect around any source of charge – whether due to unmerged meon pairs in loops or other stretched partially merged meon pairs.

As a result, what is used throughout this paper as the charge result of the twist energy $\pm qc^3/6$ is likely to be the screened size rather than the absolute size of that charge.

Since the spinning (twisting) of the meons against the background merged meon pairs causes the $\pm q$/6 charge on the meon, the charge only exists where the background is present, unlike the fundamental charge which always exists. So in a quantum mechanical system, where motion of loops occurs within tunnels that exclude the background, there are no q/6 charges generated and the M_* and Q_* energies have no transmission except between the meons and anti-meons within a loop itself - since there is always a source and sink for the merged meon pairs, as chains, to attach to.

The loops maintain size since the twisting of the meons continues, and the chains that were attached to the meons detach, so that there is no viscosity slowing the motion of the meons in the loops along the tunnel. The charge energies total zero and the $\pm qc^3/6$ charge energies are used to keep the tunnel open. Only at the tunnel ends do the chains reattach to the meons, the q/6 charges reignite and the properties of the loop become observable whilst the loop remains at that tunnel end.

For the photon, split into positron and electron, or two entangled photons, travelling through a tunnel, there are always an even number of effective currents flowing, due to the rotation of the fundamental charges of the meons in the loops, even though they add to zero within each loop and across the two loops or sets of loops. Inside the tunnel, there are no partially merged meon pair chains to transmit, or the same myriad pairs as the background to be affected by, those effective current flow effects.

The current flows are never zero, even in symmetric neutrinos, outside the tunnels, because of the partially merged meon pairs in chains that move with the loops and those same in the background, which are what they move through. So there will always be volumes, inside or outside tunnels, due to loops or the background, where the current density is not zero [19]. Every motion of every meon gives rise to a current flow – even if it is balanced by opposite current flows from another meon, inside or outside loops.

VII. STACK EFFECTS

The screening effect of the merged meon pairs, the background, means that the strong coupling constant increases as loop separation decreases and fewer merged meon pairs are in the way – similar to the effect of the stack π_s shielding, as defined later, but at a more granular level.

This is complicated by the opposite effect of the loop to loop equation in which, as explained below, the denominator has the structure $R^2 – f(Rr)$ which reduces the effect of the meon to meon constituent energies in parallel loops, along their mutual axis of rotation, as the loops reduce separation.

Further complication comes from the relative asymmetric planar angles between asymmetric loops. To achieve a stable stack requires a balance of asymmetries along the axis of rotation of the loops. So a stack with the wrong asymmetries cannot balance, and this is the result of the meon to meon energies between loops producing energies (forces) that effectively repel those loops that have the same asymmetry angles from approaching each other and attracting those whose asymmetries differ, which is a form of ‘colour’ anti-screening [20].

The background also contains the equivalent of zero spin photons, the zerons, centred at every point in space and existing at every energy. These are the source of pair creation and zero point energy.

At very small separations between meons in different loops, the internal twist-generated mass energies become more important as their addition or subtraction relative to the fundamental mass of the meons means that the size of those meon mass energies, when compared with the effective loop mass energy ½ *hw*, dominates the interaction.

As mentioned, the mathematics of energies or forces, from or to loop structures – not meons and anti-meons - which are composed either solidly, like a torus, or of separate bodies, contains in the denominator the factor $R^2 – f(Rr)$, where R is the separation between two equal sized loops, both radius r [21].

This means that, if the meon loop mathematics were the same, there is a separation distance when $R^2 = f(Rr)$ at which the energy or force between the loops is a maximum. Generally, if the energy is attractive at $R^2 > f(Rr)$, then it is repulsive at $R^2 < f(Rr)$. This is a system where two loops have a preferred separation of $R^2 = f(Rr)$ when in a stack. When the energy is repulsive at $R^2 > f(Rr)$, it will be attractive when $R^2 < f(Rr)$. The former situation describes a form of retaining structure for stacks and the latter may be a feature of loops that combine, for example, to form photons where the meons in one loop merge almost totally with the anti-meons in the other loop.

However, the mathematics of loops is not exactly the same as for a torus. The directions of actions are digital in form. If a test mass is positive and moving towards a negative meon in a loop, the negative meon tries to maintain separation and moves away from the test mass. If the test mass is positive and instead is moving away from a negative meon in a loop, the negative meon tries to chase towards the receding test mass. Exactly the same effect happens when the test mass is negative and a positive meon in a loop is considered. Motion to reduce separation by the test mass causes the loop meon to move away, whilst motion to increase separation by the test mass forces the loop meon to chase the test mass. The underlying drive is to maintain separation between opposite sign meons.

For the interaction of a positive test mass with a positive loop meon, the mass effect is attractive. The same is the case for a negative test mass and a negative loop meon – they both mass-attract. Although the meon charges, assuming the test mass to be a meon, are both the same sign here, they may not be the same size as each other due to twist mass and charge energies, but the result overall will be zero for the same-same interactions. Only direct contact transfers energy in same-same interactions.

These same-same meon interactions are the incompressible balls needed by mathematics and physics for no-energy-loss momentum transfer in collisions.

The issue is that because there are no isolated positive or negative meons, only pairs of meon and anti-meon, there will always be both actions at work in any calculation, and across three pairs in each rotating loop. Loops rotating at different frequencies will have meons in one loop chasing meons in another loop for some of the second loop’s rotation and then being chased for the remainder, with two points in the mutual rotation where there is no change in direct meon to meon separation, even if the loops’ rotational planes are parallel and they maintain overall separation between the loops’ centres of rotation.

This drive to maintain separation, and orientation, is the foundation of the actions of the spin of a loop. The energy that drives the spin is the rotational energy ½ *hw* transmitted by the chains to the background. The loop spin energy is equal and opposite to the loop mass energy, with both observable as a size of ½ *hw*, positive for mass and negative for the spin of the loop.

This latter effect of summing to zero across two different energies is the same as other balancing energies, but here these energies are emergent from the relative motions of the meons within different loops, transmitted by their attached chains.

The spin energy of a loop is always there, regardless of alignment and has an observable effect as the outward-directed spin-kinetic energy of a loop in an orbital system – doubling the total kinetic energy present in all orbital systems, regardless of loop orientation.

As a result of this analysis, the energies of an electron loop can be split into those due separately to the fundamental and twist energies of the meon masses and charges as different types of momenta

Momenta	*Fundamental*	*Twist*	*Total*
M	$\pm svr/(1-j^2)$	$\mp svr/(1-j^2)$	0
Qc	$\mp qcvr/(1-j^2)$	$\mp qcvr/(1-j^2)$	$\mp 2qcvr/(1-j^2)$

All meons have twist energies due to *s*/6 and *q*/6, it is only how many, of which twist spiral direction, are in a three pair loop that determines what is the loop identity.

The mass $M_* c^2$ and twist $sc^2/6$ energies provide loop stability and the loop frequency is what provides the action of the merged meon pair chains on the background. So regardless of what are the signs of M_* and *s*/6, the chains work on the background to provide the effect of gravitation, although, also dependent on the overall loop charge.

The net non-zero motional mass and charge energies show that there must be an internal potential energy needed to ensure the total loop system always has zero total energy. This will be considered and analysed in a slightly different way below.

VIII. POTENTIAL ENERGIES

So far only energies due to motion have been considered and these have been shown to have a net energy for charged loops due to their Q_* and *q*/6 charges rotating at two different radii which do not cancel in the way that the M_* and *s*/6 mass energies do. There are potential energies present that need to be identified.

In the initial state of a chain of meons, chasing in a straight line before catching onto its own tail to form a loop, the mass and charge energies of the meons and anti-meons will have equal sized effects from any point at a reasonable separation from the chain. So the potential energies of such a chain will be equal and opposite, due to the net $sc^2/6$ energy of the chain balancing the net $qc^3/6$ energy, provided the loop is formed of pairs of meon and anti-meon.

It is in the formation of a chain that the mass and charge potential energies change. The potential energies become structural energies that lock the chain into its loop form.

Although it is simple to identify the total potential energy, due to both mass and charge, as the balancing energy to the energies of motion, because any system always has a total energy of zero, it is useful to look at the component parts in different ways in the meons first.

The starting point is to treat the two meon types separately before summing over a loop, rather than was done in the previous section, remembering that for the electron there are only two angular momenta variants h_A and h_D used. For a positive meon its motional energy or momentum can be split into the fundamental component, twist component and total as units of ½ *hw, or h*, respectively as

Meon	*Total*	*Twist*	*Fundamental*
$+M_*$	$(1+j)/(1+j)$	$j/(1+j)$	$1/(1+j)$

It has charge components, under the same headings, but using the mass equivalent of $Q_* c$, of

$+Q_* c$	$(1-j)/(1+j)$	$-j/(1+j)$	$1/(1+j)$

So that the total motional energy for the positive meon, split into components, will be

+M+Qc	$2/(1+j)$	0	$2/(1+j)$

For the negative meon, the components will be

Meon	*Total*	*Twist*	*Fundamental*
$-M_*$	$-(1-j)/(1-j)$	$j/(1-j)$	$-1/(1-j)$
$-Q_* c$	$-(1+j)/(1-j)$	$-j/(1-j)$	$-1/(1-j)$

Giving the negative meon total as

-M-Qc	$-2/(1-j)$	0	$-2/(1-j)$

So for a pair of meons in an electron loop, the total motional energy or momentum units, split into components, will be

Meon	*Total*	*Twist*	*Fundamental*
Pair	$-4j/(1-j^2)$	0	$-4j/(1-j^2)$

for the pair.

In the following potential energy examination, the two different radii of rotation are not considered, only the 'no-twist' radius. The difference is very small, producing overall the potential energies smaller at 0.999995 versus 1 in the simple treatment.

For the two potential energy types, which in total must equal the motional energy, the internal potential energies of one pair are not the only potential energies present. There is also a potential energy from each other pair that needs to be considered.

This is best calculated between individual meons, then summed over a pair, then the three pairs. The loop symmetry means that only energies (forces or momenta) along the radial direction towards the centre of a loop need be considered, each circumferential energy (force or momentum) on each meon or anti-meon, other than their circumferential same-different mass chasing action, cancels due to symmetry in the electron loop and the drive for separation stability. The latter is what drives the loop rotation.

For each same-same $+M_*$ meon to meon interaction at a separation *d*, different for each interaction type, the potential energies for an electron will be

$$M_*^2(1+j)(1+j)/d_1 \qquad Q_*^2c^2(1-j)(1-j)//d_1$$

For the same-same $-M_*$ meon interaction the potential energies will be

$$M_*^2(-1+j)(-1+j)/d_2 \; Q_*^2c^2(-1-j)(-1-j)/d_2$$

And for both types of meon their opposite type potential energies will be

$$M_*^2(1+j)(-1+j)/d_3 \qquad Q_*^2c^2(1-j)(-1-j)/d_3$$

In each case the separation and angle that the energy (force or momentum) takes from the radial direction will be different.

For one $+M_*$ meon, in a loop of radius *r*, the total potential energy towards the central point will be

$$M_*^2(-1+4j+5j^2)/2r \quad Q_*^2c^2(-1-4j+5j^2)/2r$$

The $-M_*$ meon will have potential energies

$$M_*^2(-1-4j+5j^2)/2r \quad Q_*^2c^2(-1+4j+5j^2)/2r$$

So that, from the central point between a pair, the potential energies will be

$$M_*^2(-1+5j^2)/2r \qquad Q_*^2c^2(-1+5j^2)/2r$$

For the electron loop with three similar pairs, the total over the loop will be

$$3M_*^2(-1+5j^2)/2r \qquad 3Q_*^2c^2(-1+5j^2)/2r$$

This is the total potential energy that balances the net motional energy of the loop. This is the internal potential energies within the loop, set when the loop first formed, and are not the same as the potential energies of the loop that are observed externally, which are due to the loop mass, spin and charge energies.

The values of the loop internal potential energies cannot be directly equated to the net motional energies of the current loop because when the loop was formed, the loop energy was near Planck energy and meon-meon separation near Planck distance, so that the binomial expansion of (γ^2-1) is not valid. At current loop sizes, the expansion is valid, but the comparison will not be. All that can be said from this analysis is that the mass and charge potential energies within an electron loop are always equal.

The electron loop energies for the three meon pairs can now be shown for all energies or momenta by type in appropriate units as

Meons(x3)	*Fundamental*	*Twist*	*Potential*
$+M_*+Q_*c$	$+6(1-j)/(1-j^2)$	0	$-6/(1+j)$
$-M_*-Q_*c$	$-6(1+j)/(1-j^2)$	0	$+6/(1-j)$
3 Pairs Total	$-12j/(1-j^2)$	0	$+12j/(1-j^2)$

The total potential is shown here as positive, to balance the fundamental energy, which, since it is a net magnetic moment energy, is by convention treated as negative. The potential energies have been split equally since that has been shown by the analysis above to be the case.

Another way of looking at the motional energies within loops is by considering the mass and charge energies of both the meon types separately. The mass energy of a pair would be

Meon	*Total*	*Twist*	*Fundamental*
$+M_*$	$(1+j)/(1+j)$	$j/(1+j)$	$1/(1+j)$
$-M_*$	$-(1-j)/(1-j)$	$j/(1-j)$	$-1/(1-j)$
Overall	0	$+2j/(1-j^2)$	$-2j/(1-j^2)$

The meon fundamental mass motional energies for a pair have been reduced at the expense of the same size increase in twist motional energies. Despite the total motional energies being zero, effectively because the meon and anti-meon energies are always equal and opposite, the loop continues to rotate at frequency ½ *w*.

For the charge motional energies the split for a pair will be

Meon	*Total*	*Twist*	*Fundamental*
$+Q_*c$	$(1-j)/(1+j)$	$-j/(1+j)$	$1/(1+j)$
$-Q_*c$	$-(1+j)/(1-j)$	$-j/(1-j)$	$-1/(1-j)$
Overall	$-4j/(1-j^2)$	$-2j/(1-j^2)$	$-2j/(1-j^2)$

This shows that the total charge motional energies for a pair are split equally between the fundamental and twist energies.

Putting the mass and charge motional energies together in the electron loop with three similar pairs produces

Meon (x3)	*Total*	*Twist*	*Fundamental*
$+M_*-M_*$	0	$+6j/(1-j^2)$	$-6j/(1-j^2)$
$+Q_*c-Q_*c$	$-12j/(1-j^2)$	$-6j/(1-j^2)$	$-6j/(1-j^2)$
Total	$-2q/(1-j^2)$	0	$-2q/(1-j^2)$

where the total has been displayed in terms of the electron charge size q. The effect of offset radii of rotation is to double the charge motional energy that would be the case for meons all rotating at the same radii. The rotating *q*/6 charges still produce their total external observable charge q.

These observable motional energies for the electron loop in their various forms can be identified and reformed, by matching the effect of the mass twist energy with the charge twist energy, using the previous section results, since what is observable are the effective mass and charge energies separately, as

Energy	*Fundamental and Twist*	*Twist alone*
$Mass$	$+½\ hw\ Mass$	0
$Charge$	$-½\ hw\ Spin$	$Magnetic\ E_\mu\ and -q$

The identification of the M_* fundamental and *s*/6 twist masses together as the driving energies for chains that produce the mass effect is because the meons continue to chase around the loop, despite each meon motional energy being positive and each anti-meon motional energy negative. The total is zero, yet they move.

This means that all that is seen due to the meon fundamental and twist energies, regardless of twist sign, is the effect of the attached chains of meon pairs, which transmit the effect of ½ *hw*, the loop 'mass' to the background.

Spin is an emergent effect, because it would not exist if the loop had not formed from a chain. The same is the case for the mass energy ½ *hw* of a loop. Unlike the spin energy -½ *hw* of a loop, which is always the same size, although directional, the mass energy is mediated by the overall net loop charge.

The motion of the fundamental Q_* charges is responsible for the spin energy of the loop and is the same for all loops because they all have the same fundamental charges. In the reformed energy identification, it is only the fundamental Q_* charges that produce the spin effect and, because they sum to zero over the loop, the latter is not affected by what is the sum of the *q*/6 charges.

The *q*/6 charges produce the total loop charge, q for the electron, and part of the magnetic moment of the loop.

The reason why the loop mass energy is mediated by the loop *q*/6 charges, but the spin energy is not is because, whilst they are attached to the meons, the partially merged meon pairs that comprise the chains rotate, vibrate and spin to transfer the properties that can be reflected in their motions. Those properties are the frequency of loop rotation and *q*/6 charges of the meons, which sum to the net loop charge, whereas the total loop Q_* charges have no direct effect, beyond very small meon-meon separations, since they sum to zero.

Chains produce greater effects when sweeping through the background, mostly composed of a myriad of partially merged meon pairs which are like a dielectric soup, when their effect includes a net charge of the loop to whose meons they are attached.

When the net charge on the loop is zero, there may still be a small effect on the background due to the chains.

So the effect of the spin interaction with another loop along the axis of rotation of a loop starts at zero in the plane of the loop and increases with separation until around 10^5 loop radii from the loop it where it closely approaches its maximum value of -½ *hw*.

But once beyond a certain distance, an external loop can no longer experience the spin orientation effect of the chains attached to the loop. Beyond this point the relative spin orientation of the loops no longer interact, the external loop experiences the size of the spin but not its orientation.

The fundamental and twist energies still exist and the kinetic energy of the spin energies acts in orbital systems in exactly the same way as the mass kinetic energies, outwards from the centre of rotation.

IX. REINTERPRETING EQUATIONS

The energies just calculated, from meon up to loop level, need to be reformed in the standard Quark Model way [22], including spin orientations in the equations. The masses of two loops, m_1 and m_2, each with spin orientations S_1 and S_2 , charges q_1 and q_2 and generating magnetic fields B_1 and B_2, will have a total mass-related interaction energy, due to an external interaction energy E, of

$$E_{Mi} = m_1c^2 + m_2c^2 + m_1c^2m_2c^2S_1S_2/E - m_1m_2/r_{12}$$

Although only useful as a numerical check, this will be equal to the charge interaction energy, once adjusted by the ratio $D_{\mu/m}$, of the only two loops present observed as a magnetic moment in their mutual magnetic fields, of

$$E_{Qi} = [\mu_1B_2/D_{\mu/m1}] + [\mu_2B_1/D_{\mu/m2}]] +$$

$$[\mu_1\mu_2B_1B_2S_1S_2/E]/(D_{\mu/m1}D_{\mu/m2}) - q_1q_2c^2/r_{12}$$

Strictly these two are equal only when considering the magnetic moments due to the meon M_* mass and charge Q_* effects, not when looking at the loops themselves at their ½ *hw* mass energies. From above, for two identical loops, the first three terms should be identical. The potential terms relate to the observable mass ½ *hw* of each loop, and the loop charges.

In hyperfine energy level splitting considerations it is the change in energy and magnetic moment due to the spin-spin interactions S_1S_2 that is required to aid in the determination of hadron masses and magnetic moments.

Although the potential energies should change, the effect will be small by comparison, since the two loops will not be in a stable mutual orbit, so it should be the case that the energy difference E_d will be

$$E_d = m_1c^2m_2c^2S_1S_2/E$$
$$= [\mu_1\mu_2B_1B_2S_1S_2/E]/(D_{\mu/m1}D_{\mu/m2})$$

If these were the only two loops present, then the two energies would be the same and it would be possible to equate the spin-spin interaction energy of the two energy types.

However, in the hadrons, as proposed in the PFH and detailed later, there are more than the two loops present and the equating of the two energies is not strictly correct since there may be loops with spin but no mass, or mass but no spin, amongst the LQL stack π_s , as defined below.

In the Quark Model there should be some direct relationship between a two-loop energy change due to parallel and anti-parallel spin orientations due to mass and charge effects for both electrostatic and colour couplings. In the standard usage [23] of the QCD strong coupling factor α_S and QED mass spin-spin factor *A* for such energy level splitting, it should be the case that

$$E_{QED} = A\, S_1S_2/(m_1m_2)$$

and

$$E_{QCD} = \alpha_S k S_1S_2/(m_1m_2)$$

with $E_{QED} = bE_{QCD}$, where *b* represents a dimensionless factor that is not necessarily constant, and where *k* is the complex factor that is usually skimmed over as a proportionality between α_S and E_{QCD}. In this equation, the c^2 factors have been included within *A*, so that as an energy equation it has dimensionality of Y^7, effectively being m^3 c^2. Usually [24] the values of *A* are quoted in GeV^3, representing E^3 and dimensionality Y^{15}. The difference is only the additional four c^2 factors, included and excluded implicitly within the Quark Model, which uses masses in MeV instead of MeV/c^2.

The value of α_S is quoted in T^2/J or a more complex mixture of units. This is a dimensionality of $(Y^{14}/Y^5) = Y^9$, so that as a result the dimensionality of *k* is Y^{-2}. This latter is not a simple *c* factor but is a general mixture of

$$k = m^3c^2E/B^2$$

From a purely mathematical aspect, since E in both mass and magnetic moment equations for the limited two loop system must use the same analogous spin-spin relationship, then it should be the case that

$$k = A/(b\alpha_S)$$

But *k* is not a constant due to its non-zero dimensionality.

The issue is that this two loop system is unlikely ever to occur, so that the two factors *A* and $b\alpha_S$ may not even have any direct form of relationship. This is borne out when comparing some usual factor values quoted for the Quark Model [25], which appear to bear no relationship.

What the relationship says, in a simple system, is that the coupling constant is dependent on the energy (momentum) of the interaction, through the energy *E* in *k* [26]. The twist energy is constant, and may be higher than $|q/6|c^3$, but what can be observed depends on meon to meon and loop to loop separation, meson velocity (loop momentum) and shielding, merged meon pair screening, asymmetric anti-screening and local background density.

Without knowing the actual size of meons and loops, QED uses an energy cut off to avoid infinities [26] which is equivalent to saying that particles are not point masses. The renormalized coupling constant [27]

$$g_R = g_e\sqrt{(1 - (g_e^2 \ln(M^2/m^2)/(12\pi^2))}$$

implies that for a real g_R, the cut off mass equivalent *M* and hadron mass *m* need to be at least $M < m\, e^{6\pi^2/g_e^2}$. However, if the sizes of the meon and loop radii were known, then there would be no need for a cut off. Although this is a QED factor, the same applies to an even greater extent in QCD.

So there are not different quark energy levels for different interactions – the pure quark loops do not change energy, other than in relativistic motion, except by having other loops (photons, stack π_s, etc) stacked with them and treating the whole stack as if it were the quark loop alone.

X. CALCULATING THE HADRON MASSES AND MAGNETIC MOMENTS

In certain of the Quark Models [28], the masses of the hadrons requires certain quarks to have certain masses in order to reproduce the observed hadron masses. At the same time, these certain masses do not produce the magnetic moments of those same hadrons [29, 30].

The PFH loop-stack interpretation manages to produce both the hadron masses and magnetic moments to better accuracy, in both cases using consistent masses throughout. It does so from the proposition that the quarks masses are unchanged and relatively small (current masses), and that the 'missing' mass and spin energies are due to the existence of the various meson double loops in the stack.

Thus the accuracy of QED/QCD calculations comes not from the use, for example, within Feynman diagrams of unaligned photons, mesons and quarks with gluons as force carriers, and because those photons, mesons and quark loops exist and interact with each other with certain energies. Instead it is the merged meon pairs that do the job of transmitting forces.

In this framework, what is observed in an interaction will be the independent loops separately from the remaining parts of the loop stack, which latter contain the valence quarks and the remaining shielding stack loops, dependent on the energy of interaction.

Where different stacks interact, the mixing of the valence quark and stack loops, through the intermediate stage of loops breaking into chains, will produce the anticipated different stack outcomes, with the shielding adjusted to the new identities of the new stacks or valence quark loops and ejected loops.

The fundamental point is that the total masses of all the component loops in a stack will be very close to the mass of that hadron as a whole. There may be binding energies, but they are accounted for as part of the independent loops themselves, rather than the smaller valence quarks. Only where the larger valence quarks are part of a stack will their mass contributions become significant.

The hypothesis is also built on the premise that the smaller charged quark in a quark family, such as the down quark, has a mass effect half that of the larger charged quark, the up quark in that family. This is because the former has half the total loop charge of the latter and the mass effect of each is due to the net strength with which the meons, which comprise the loop, and their attached partially merged meon pair chains, interact with the background of myriad other merged meon pairs and zerons. That strength depends partially on the loop total charge since the loop radius in each quark family is the same – as required for the symmetric balancing of quark rotational asymmetries in a stable stack, or in part of a stack which is a balance of loop asymmetries.

This is completely the reverse of currently accepted interpretations [31] which imply that low energy down quarks have twice the mass of the relevant family up quarks and that at high energies the two are the same. In the PFH, one is always twice the mass of the other – at all energies.

Since the two larger families each have their positively charged quark larger than the negatively charged sibling, it would seem more likely that the smallest family would follow that relationship – supported by the larger charge producing the stronger merged meon chains that interact with the background. However, the direct ratio of their charges is not observed to produce the same ratio of masses as hypothesised here.

The identities of the independent stack loops are the leptonic mesons in charged or uncharged forms, with or without J^p spin. These, the π^+ and π^0, have the masses that are observed for them and are stacked only loosely, because they are capable of independent existence. The less independent leptonic/quark-like (LQL) stack mesons are composed of pairs of muon/electron loops/anti-loops, zero total charge neutrino/anti-neutrino loops, 'small' ρ^+ and ρ^0 and quark/anti-quark pairs, with $J^p = 0\ or\ \pm 1$ and are the stack π_s mentioned above, now more generally described as LQL stack π_s .

It is these additional meson masses that contribute to the current interpretation of the quarks having higher energy in strong interactions.

The lepton families are, like the quark families, only larger or smaller versions of each other. So the leptons can change the radius at which their meons rotate in their loops, meaning their masses, provided they simultaneously change their spin energies, which are observable as their spin and magnetic moments and the addition/reduction of rotational frequency is taken from/given to other loops.

What this means is that within stacks, the LQL stack π_s can take any size, meaning mass, equal to or greater than twice that of the electron, and these are the loops that shield the valence quark loops. In all the tables below, there is only one size of LQL stack π_s that is used in every calculation of the baryon and meson masses and magnetic moments. Since the calculations are quite successful in replicating the different hadron masses, it appears that the size used may be a preferred size, although how that is split between the loop masses and binding energies in that LQL stack π_s is not yet amenable to discovery.

XI. METHODOLOGY

The basic method of estimating quark and hadron masses is, as mentioned earlier, to hypothesise that the sum of the component valence quarks, π^+ , π^0 and LQL stack π_s masses totals the baryon or meson mass. Initially in the process this was deliberately made exact for the pion, by equating the stack content of the π^+ and the π^0 and treating the quark content as a simultaneous equation. Since the framework also hypothesises that the mass of the up quark is twice that of the down quark, this was simple.

However, the result would be that the π^+ and π^0 themselves, as independent loops, would have the only stack π_s at a different mass to all of the stack π_s loops in other hadrons.

So, for consistency, the LQL stack π_s mass, shown later, was used as the only shielding stack π_s, and the newly calculated masses of the π^+ and π^0 were adjusted to be near their correct sizes by appropriate setting of the mass spin-spin coupling factor and valence quark masses. This factor was then used for all the particle mass energy calculations.

This latter treatment is different to the currently accepted sizes of the mass spin-spin coupling factor, which is estimated to be different in the mesons and baryons [32]. The coupling factor *A* that has been used here is different to than those in the Quark Model [33].

To estimate the size of the general stack π_s mass, the Eta and Eta prime were used in another simultaneous equation. However, since it is observed that the latter always has break up products two pions more that the former [34], this was included in the calculation. The number of stack π_s in the Eta was then iterated to produce equal stack π_s sizes trying 1, 2, 3, 4 and 5 stack π_s in turn to arrive at an estimate of the mass of the strange quark (and therefore the charm quark).

Consideration was then given to how many of the loops in the η and η' stacks are core shielding stack π_s and how many are π^+ and π^0 independent stacks. Those core LQL stack π_s were assumed to be the same size in all stacks, with the independent ones the accepted π^+ and π^0 sizes. The result was that the η at 4 pions in total and the η' at 8 pions in total provided the most accurate result overall when calculated on the basis of the least-square method used on the fractional inaccuracy of the calculation for every hadron mass used.
These results were used as a starting point to be fed back into the calculations initially to reduce the difference between the estimated and observed values of the masses of the hadrons. This 'least-squares' process was applied to each hadron individually, by baryon or meson type, section and overall.

What was found was that there are 'attractors'. Continual interpolation from different starting points suggests that there are many 'attractor' values for the four variables of LQL stack π_s , mass spin-spin coupling factor, up and strange quark masses. Those are the four variables required to adjust the least-squares accuracy.

These attractors appear when the least-squares method arrives at its lowest end value that does not change when any of those variables are slightly altered. The bottom quark value used was always set automatically by the 'total inflation' framework described below, so was not a direct variable.

Although initially the number of π^+ , π^0 and LQL stack π_s were set to be the same across each octet or decuplet family level, that system did not produce the observed magnetic moments for the baryons for which magnetic moment values are available.

So the least-squares method was extended to include the accuracy of producing the magnetic moments of those baryons as well as their masses across all ground states of baryons and mesons.

This was achieved by adjusting the π^+ , π^0 and LQL stack π_s numbers individually in those baryons whose magnetic moments have been observed, using the Quark Model methodology for estimating their composite valence quark plus shielding masses and then using those to obtain their magnetic moments.

The mass spin-spin factor was used to generate the best-fit least-squares combination of valence quark plus shielding meson masses for each valence quark, and across each valence quark pair present in each hadron. The additional spin-spin mass adjustment for each hadron was split equally between the valence quarks present, modifying the quarks' individual shielding.

Those composite masses for each valence quark plus shielding were then used to generate the magnetic moments of those composites in order to produce the total hadron magnetic moments. The stack structure in the PFH allows for the simple addition of the composite loops' magnetic moments as the loops in the hadron all have the same rotational plane perpendicular to the axis of their centre of rotation.

In Tables 3 and 4 the hadrons are split into sections based on type (baryon or meson respectively), J^p spin values and type of quark content in the composite. Any π^+ or π^0 expected to be dislodge are noted in the two columns 'Independent Pions' and are deducted from the non-quark remainder to produce the mass expected to be composed only of LQL stack π_s. The total meson number includes all LQL stack π_s, π^+ and π^0 expected to be present in the stack. Some baryons that have other baryon content as a first break-up product are considered to be further broken down from the latter so that just the core LQL stack π_s remain and the additional π^+ or π^0 are added to their respective columns.

These then provided part of the least-squares result for all the masses and magnetic moments. This produced the result that the number and type of stack meson usually varies across component quarks, even in the *Omega*- with its three strange quarks, as shown in Table 1.

The four variables were adjusted and the least square calculation repeated many times to eventually obtain a stable result where the mass and magnetic moments, LQL stack π_s size and the size of all quark masses were consistent at the lowest least-squares value for that attractor. This was repeated to find the lowest least-squares attractor value. No odd total numbers of π^+pions were used in any hadrons.

The PFH estimated values used here in all tables are for the attractor whose final least-squares value was the lowest found - although this does not mean that there is not one, or more, other attractors with lower least-squares values.

Table 1 shows the results of the estimations of the relevant baryon masses and magnetic moments using the PFH methodology. The results of the best Quark Model mass and magnetic moment inputs [35] are shown in the columns marked 'QM Best' as comparisons. The basis for those 'QM Best' estimates, each property being based on different variables, clearly demonstrates that the Quark Model has inconsistencies – in order to produce the baryon magnetic moments requires different quark masses to those required to produce the baryon masses.

In Table 1 the columns marked 'QM Best' use the values that produce the closest masses or magnetic moments for the baryons for which there are observed magnetic moments. The QM Mass section uses $m_u = m_d = 363$ MeV/c^2, $m_s = 538$ MeV/c^2, and A = 0.026 $(GeV/c^2)^3$. The QM Magnetic Moment section uses $m_u = m_d = 336$ MeV/c^2 and $m_s = 509$ MeV/c^2.

Although the cumulative accuracy of the PFH estimates is not as good as the QM Best figures, it is the least-squares fit that is more important for the baryons modelled. Overall the hypothesised framework produces better overall accuracy in both the hadron masses and the magnetic moments than the Quark Model. It uses the same consistent masses for the LQL stack π_s, up, down and strange quarks and the same mass spin-spin factor in both baryons and mesons.

The strange quark was considered strange because it slows down the rate of decays [37], but this is only a consequence of the time needed to transfer the higher frequency of its larger mass to other loops when compared with the much smaller transfer needed for the smaller masses of the up and down quarks, effectively like a relativistic time dilation type effect.

The attempt to use the same process for the bottom quark mass was not as successful, since there is no clear and simple simultaneous equation to use. The mass could be anywhere between 500 and 20,000 MeV/c^2, with the adjustment in stack meson number changing to balance.

The end result this leads to has an overall cumulative average accuracy of 0.05% and overall cumulative average inaccuracy of particle mass energy of 3.66 MeV/c^2 as shown in Table 2.

The individual results, as shown in Tables 3 and 4 for the baryons and mesons respectively, are basically in line with the lower energy calculations generally accepted [38], using the estimated mass of Up quark as 5.138 MeV/c^2 and the Down quark as 2.569 MeV/c^2, although, as mentioned earlier, their currently understood relative low-energy sizes are reversed. But in the PFH framework, the quarks themselves do not have high or low energy states, other than due to their own relativistic motion or in having attached stack loops.

For the strange quark the estimated mass is 129.33 MeV/c^2 and the charm quark twice that at 258.33 MeV/c^2.

By using the 'total inflation' framework explained below, the estimate for the bottom quark mass is 288.7 MeV/c^2 (and the top quark twice that at 577.5 MeV/c^2). This is the figure used in Tables 3 and 4 below showing the estimated

LQL stack π_s numbers for some hadrons and mesons containing bottom quarks.

XII. RESULTS EXAMINATION

An overall reasonably accurate estimate of the masses of the hadrons examined and of the magnetic moments of the baryons with observed magnetic moments has been calculated. At the point of least-square minimum for cumulative fractional inaccuracy across all the ground state hadrons masses and magnetic moments, the best fit mass size of LQL stack π_s is 75.38 MeV/c^2. This represents an LQL stack π_s where the total of the mass and binding energy is always that size, with the actual masses of its leptons, quarks or neutrino components any size in total up to that maximum amount.

The mass spin-spin factor used across all the hadrons was 335 (MeV/c^2)^3, which compared with A = 0.06 $(GeV/c^2)^3$ for mesons and A = 0.026 $(GeV/c^2)^3$ for baryons in the Quark Model [39].

The valence current quark sizes were estimates using the PFH methodology in MeV/c^2 to be

Down	2.569	Up	5.138
Strange	129.33	Charm	258.66
Bottom	288.7	Top	577.5

The sizes quoted here are to lesser precision than used to target the best least-squares results. This compares with the generally accepted MS scheme central low energy current quark masses in MeV/c^2 [40]

Down	4.8	Up	2.3
Strange	95	Charm	1,275
Bottom	4,180	Top	173,210

The c, b and t quarks are all smaller than QCD theoretical estimations [41] and experimental observation appears to show, but this may be due to the sheer number of mesons in their stacks which continue to shield them and bulk up their observable masses. The pre-fermion 'total inflation' proposal limits the three charge-related family loop sizes to be the same in each family and proportional to those charges.

The pions themselves each have two LQL stack π_s, and the spin-spin coupling factor at 335 (MeV/c^2)^3 reduces the effective mass near to the expected values.

As shown in Tables 5 and 6, there is reasonable consistency in the modal total stack meson numbers for the baryons and the core LQL stack π_s numbers (the number of LQL stack π_s which remain shielding the valence quarks), represented by total stack/core π_s number with the main number. The latter may be different due only to a small excess/deficit of the total non-valence quark remainder mass that makes the integer number of stack pions higher/lower rather than the reverse.

Table 5 shows how total stack pion and core LQL stack π_s numbers change due to J^p spin and charm. The column 2Qaverage represents twice the sum of the charges of the possible variants of each type of hadron.

For the $J^p = 3/2$ baryons and meson there is almost complete consistency in the total pion to core LQL stack π_s ratio.

For the mesons shown in Table 6, the $J^p = 1$ set are consistent, whilst the $J^p = 0$ set are fairly consistent.

Generally for the meson set, moving from $J^p = 0$ to $J^p = 1$ adds three independent mesons, keeping the core stack π_s unchanged. For the baryon set, moving from $J^p = 1/2$ to $J^p = 3/2$ the independent mesons are unchanged, whilst the core stack π_s are reduced by three stack π_s.

Table 7 shows the bottom quark baryon section. The break-up versus core pion number is more complex, so the simple estimate of how many LQL stack π_s are present is shown. This is clearly not the correct content because of the relative sizes of the π^+ , π^0 and LQL stack π_s. Thus it appears simply as a general trend that, as expected from the framework used here, the number of LQL stack π_s increases as the hadron masses increase, although the actual split of numbers of π^+ , π^0 and LQL stack π_s is not clear. Here there seems to be no change in the independent meson or core stack π_s numbers between $J^p = 1/2$ and $J^p = 3/2$.

Consideration of the average mass per total stack meson number, based on total hadron mass, suggests that possibly a handful of the listed hadrons could be better fitted by adjusting the stack number by one LQL stack π_s. However, this runs counter to the choice of closest integer stack number and decreases the overall accuracy whilst being unphysical when the estimated baryon mass would be obviously excessive. This suggests that the average mass per LQL stack π_s or stack meson is of limited value.

Interestingly, the average mass sizes of the up and down quarks with their respective shielding mesons in the baryons in Table 1 are relatively equal, as in the Quark Model values [42]. The hypothesis produces - up 373, down 374 MeV/c^2 versus the former at - up 336, down 336 MeV/c^2. The PFH and QM sizes are different, but both have the same size in the up and down quarks.

This suggests that the PFH is reasonable in this context.

XIII. MATTER AND ANTI-MATTER

Table 8 shows the result of splitting the baryons and mesons into their matter and anti-matter sets. The standard octet and decuplet arrangement mixes positively and negatively charged hadrons together and defines the 'regular' particles to be the up and down quarks, electron and neutrino.

The PFH being utilised here instead insists that if a positively charged particle is defined to be the matter particle and its negatively charged equivalent as the anti-matter particle, then all positively charged particles are matter and all negatively charged particles are anti-matter.

Although the precise definition of a loop and an anti-loop requires that every property, including directions of motion of each meon and anti-meon [43], is mirrored, because there are more degrees of freedom in the structure of a loop composed of twisting meons and anti-meons, it transpires that the same result can be achieved for loops simply by replacing each meon with an anti-meon and vice versa. This means that the anti-particle of the spin +½ electron is the spin +½ positron, not the spin –½ positron, as required by QED [44]. This also satisfies the correct requirement for helicity of particles since the meons travel in a helix as they rotate and translate [45].

Thus the octet, nonet and decuplet sets each need to be split into a matter set and a separate anti-matter set rather than a particle set and an anti-particle set, and a neutral matter set for clarity.

The definition of a composite stack is driven in the PFH by the net identity of the quark content – a baryon stack consisting of two anti-matter quarks and one matter quark is identified as an anti-matter baryon, even if the total stack charge is zero. It is effectively the number of negatively charged quarks versus positively charged quarks that defines the stack as matter or anti-matter. Stacks with equal numbers of each are neutral matter, provided their total charge is zero.

Replacements for these sets are what are shown in Table 8, with the zeron Z_e^0 (spin=0) and photon γ_0 (spin=± 1) added since neither these nor the mesons are force carriers. All two-loop composites should be included within any attempt to produce a symmetry group. The failure to use the c quark in the replacements for the octet, nonet and decuplet means that they will never be able to produce real symmetry groups.

The ugly result of splitting the non-symmetric u, d and s grouping is that the shape of the decuplet changes because the placement of each composite now measures d versus s content for the anti-matter baryons and $\underline{d}$ versus $\underline{s}$ for the matter baryons. (The use of underlining for anti-particles is due to the limitations of the system used to produce the paper, so the anti-particle of A^+ is $\underline{A^+}$ in Table 8.

In the baryon $J_p = 1/2$ section of Table 8, there are three missing particles labelled A, B and C, with anti-particles. These are the particles with three similar quarks as their content, ddd, uuu and sss, or their anti-quarks. They are notionally forbidden by the Pauli exclusion principle, but depending at which level this works, these may be viable.

The main implication is that whilst the proton, formed from two matter up quarks and one anti-matter down quark is overall positively charged and thus a net matter particle, the neutron, formed from two anti-matter down quarks and one matter up quark, is overall neutrally charged but is an anti-matter particle overall. This is confirmed by its – ½ spin when compared with the + ½ spin of the proton in the same orientation, similar to the old isospin concept [46].

This helps explain the presence of neutrons with protons together in nuclei, as stable nuclei have equal numbers of matter protons and anti-matter neutrons. It also shows that there is no overall matter/anti-matter imbalance in the universe, although our local environment has the positively charged proton as its base.

At low energies, this positively charged local environment probably influences the preferential emission/absorption of π^+ rather than π^- between the proton and neutron [47], the π^+ sharing the charge sign of the local environment between what are effectively two uncharged neutrons, which are anti-matter particles needing a type of shielding.

One interesting aspect of splitting the matter and anti-matter sets is that within the neutral matter set the neutral kaons are both identified as neutral matter particles, being one quark and a different anti-quark. The neutral kaons are thus different from the other neutral mesons which consist of a quark and its anti-quark.

No account is taken of the mass difference between the quark and different anti-quark in the definition of its matter type, but for every other meson, except the neutral mesons that are equal mixes of quark and same anti-quark, there is both a matter version and an anti-matter version.

The neutral kaons are the exception and, because the anti-loop of a spin +½ loop is also spin +½, the relative physical locations of the quarks in the neutral kaon stack may have different effects. This may be a potential reason for CP violation in neutral kaons [48] and other mesons whose neutral charges and dissimilar quark/anti-quark content mean that both meson and anti-meson are the same sign of matter.

The original octet and decuplet hadron treatment was a useful step because it highlighted SU(3) symmetry, which would not have been the case in the split matter and anti-matter sets unless all the anti-particle hadrons had been mapped as well.

The use of d $\underline{d}$ and s $\underline{s}$ as the axes for identifying where a particle sits is because in the new definition of matter and anti-matter there are different particles that have the same isospin [49] and strangeness values. The neutral matter mesons have their own graph in order to emphasise that they are different to the matter and anti-matter sets.

It is possible to change the colour of a quark by temporary attachment of a photon to the quark loop, passing across the correct rotation to move the line of planar asymmetry around. To achieve this requires that the transfer is of integer units of h from the photon and fractional units of h of the quark. Given the threefold asymmetry of the quark loops, this latter requires that $w_\gamma = w_q/N$, where N is an integer divisible by three.

However, the transfer will alter the quark loop frequency, so the change may only be temporary, until the loop has been slowed back down to its normal frequency by the background viscosity.

For normal frequency transfers, without colour change, the requirement is that the photon frequency loss of dh must equal the quark frequency gain ph, where d and p are both integers, so that the energy transfer δE will be

$$\delta E = ph\left(w_{q2} - w_{q1}\right) = dh(w_{\gamma 2} - w_{\gamma 1})$$

This means that the strength of any interaction between a photon and a quark, in adding frequency, will be proportional to the energy of the quark [50].

The reinterpretation of matter and anti-matter particles in terms of loop charges leads to some interesting redefinitions. An uncharged neutron star will now be an anti-matter star. The alteration of a positively charged matter star into an uncharged anti-matter neutron star must take place by emitting all the former's positive charge, and vice versa for a negatively charged star.

The fusion of hydrogen into heavier particles of greater density may in part be driven by the need to emit charge to become as neutral as possible.

Neutral stable orbital systems balance motional and potential energies to zero, but do nothing to minimise net charge if on one component body only. A net charged and unstable state can reduce its charge imbalance by emitting charge – either ejecting eg a muon or alternatively fusing neutron-rich nuclei to reduce the average charge density of a nucleus.

A large black hole could change from being overall uncharged to become either a matter or anti-matter object overall by absorbing a single positron or electron, respectively.

XIV. SOME OTHER CONSEQUENCES

The loop hypothesis allows loop stacks to be longer than might be expected, provided the shorter sections of stack are also self-symmetric overall. This means that those stacks will be easier to break apart into their separate-symmetric parts. So even though threefold asymmetric quarks will form cores based around three loops, each with differently angled planar asymmetries, this does not preclude either symmetric loops, such as symmetric photon, neutrino and electron loops, or other stacks of threefold asymmetric loops with overall balance, to be attached to each other forming a longer stack. Pentaquarks stacks could be a consequence, two versions being three threefold asymmetric quarks as a stack with either a quark/anti-quark stack, or two two-fold asymmetric neutrinos, attached.

This is also the hypothetical basis for all the hadrons being a mixture of an aligned balanced valence quark stack interspersed with balanced π^+ , π^0 and LQL stack π_s stacks.

The existence of twofold asymmetric neutrinos, two variants of symmetric neutrinos and symmetric anti-neutrinos which are only 60^0 of rotation different to symmetric neutrinos, in all neutrino families, may help in the neutrino oscillation [51] issue, by providing more variants that can change size between families.

It is not clear that the Pauli exclusion principal completely forbids the formation of, for example, a spin ½ *Omega*-baryon. It depends on which level the exclusion principal operates – fermions more generally, individual independent loops or groups of loops in a stack- because in the loop stack hypothesis, each strange quark in the *Omega*- does not necessarily have the same shielding stack π^+ , π^0 and LQL stack π_s . So whether that means each total of valence quark plus shielding mesons in that stack occupies a different quantum state overall is not clear.

Apart from loop and anti-loop rotating in the same sense (same spin) where meons in one loop merge with anti-meons in the other loop, there is no way that two loops can occupy the same toroidal volume in space. Two identical loops inserting within one another is not possible because, considering one meon/anti-meon pair in one loop, the intervening particle from the other loop will always be either a meon or an anti-meon. In both cases, the chase action of the meons in the first loop will be broken for one or other of the meon pair. A positive meon being inserted may be accommodated by the negative meon of the pair, but the positive meon of the pair will not be, breaking the chain of chasing meon and anti-meons, and vice versa for a negative meon insertion.

So it is not possible to have two loops with the same energy (radius, frequency) and orientation (spin) occupy the same position (toroidal volume) in space. This may be the foundation of the Pauli exclusion principle, although it is not clear at which separation between loops such a break in chase action would occur. But such interactions will be the case when actively breaking loops and converting them into other loops, although that would require relative motion of the loops so that they could not be in the same state for all properties, given that a centre of mass system may not necessarily be a centre of charge system.

The two photons versus three photons decays of spin 0 versus spin 1 pions and rho mesons respectively, is physically explained as resulting from the interaction of the background zerons with those double loops. The zerons exist everywhere and matter and anti-matter loops do not annihilate but instead form photons.

The incoming spin zero π^0, for example up quark and anti-up quark, needs only one zeron, made from electron and positron with zero total spin, from the background to provide and match one of the pion's spin components, eg the up quark. In the process, the pion loops must change meons to become charged leptons, with zero total charge. The down quark, having changed into an electron, will match spin and opposite charge of the positron from the zeron to become a spin +1 photon. The up quark, having changed into an positron, will match spin with the electron from the zeron, becoming a spin -1 photon.

For an incoming spin +1 rho meson, the requirement, after reforming from quarks into leptons, is for two background zerons, each supplying one loop of the appropriate spin and charge. The result will be two spin +1 photons and one spin -1 photon, or vice versa. The process is one of breaking and reforming the incoming particles and then switching loops around with the already-existing background zerons.

XV. INFLATION AND MASS SIZES

One of the aspects of the PFH on which the mass framework is built is that the quark charge sizes influence how much the loops themselves show as mass. The effect for the uncharged leptons is not so direct, since, if they are massless, they can change size without energy loss, but will have preferred sizes matching the loop frequencies of the charged leptons. If they do have a small mass, the cost of changing size will be small compared with that of the charged leptons.

The quark loop mass-charge effect implies that the greater charged quark loops have twice the mass effect of the lesser charged quark loops, despite both being the same loop radius within each family, meaning loops with net charges of ± 2/3q have twice the mass effect of loops with net charges of ± 1/3q.

The estimated inflation effect is based on the hypothesis that the total amount of inflation of our Big Bang across all families of each loop type is the same. Considering the charged leptons, whose loop mass-charge effect is 3/3, this means that the electron at 0.511 MeV/c^2, muon at 105.658 MeV/c^2 and the Tau at 1776. c^2 must be the result of three different relative inflation rates along the three spatial axes with each loop's plane inhabiting one of the three planes formed by those axes after the inflation ends. The differential result is that the relative inflation rates would be 2.931, 0.174 and 606.14, two together producing in each plane the three relative lepton mass sizes, giving the total relative inflation rate of 309.733.

However, this is not the total inflation rate because the loops all start at the inception of a Big Bang at around the adjusted-Planck energy, meaning a loop radius of about 1 adjusted-Planck length, so that there is a base inflation rate to be added along each spatial axis.

This amount can be related to the largest loop, the electron/positron loop, as that is the greatest amount by which any loop has been increased in radius. The frequency of a loop is directly proportional to its energy and inversely proportional to the square of its radius, so that for each inflation plane, defined by two axes, the base inflation rate along each axis will be the same as the increase in radius of the loop. For the electron this increase in size of loop radius from the adjusted-Planck length to the present electron loop radius will be just under $7x10^8$, using DASI units, along one axis.

This means that overall the base amount of inflation along all the three axes will be $3.4x10^{26}$. The relative inflation rate for these maximally charged leptons increases the total inflation to about $1.1x10^{29}$.

The neutrino family has similar totals of base plus specific inflation rates as the electron, muon and tau loops, but, even though there are still chains of partially merged meon pairs attached to each meon in the rotating neutrinos, which transmit the rotational rate of those loops to the background, the absence of total charge in the neutrino reduces the mass effect to almost zero.

Only the relative charged lepton inflation amount is used to estimate the size of the bottom quark in the same 'total inflation' calculation where the down quark has an estimated mass of 2.569 MeV/$c^2$and the strange quark an estimated mass of 129.33 MeV/c^2. This produces an implied mass, for the same total inflation amount as the charged leptons, of 288.7 MeV/c^2 for the bottom quark, which is the mass that has been used in the overall mass estimations where a bottom quark is present.

Since the framework is based on the loop sizes for each quark family being the same size, despite their mass effects being different, the total inflation amount acting on the up, charm and top quark loops is the same as for the down, strange and bottom quark loops, producing twice the mass effect of the former relative to the latter.

However, the direct relationship between the two different sets of individual inflation axes rates has not yet been established. There must be one because there was only one inflation amount acting on all loops in our inflation event, although there may be different effects at work on asymmetric loops which reduces the effect of inflation on them, resulting in smaller radii, meaning larger masses.

XVI. OVERALL ACCURACIES

Although the framework of core LQL stack π_s and independent stack π^+ and π^0 plus quarks summing to near 100% of the observed mass of a hadron is hypothetical, the accuracy that can be managed is reasonably persuasive. In any section of hadrons shown in Table 2, the maximum cumulative average inaccuracy in the estimated baryon masses, using the framework for the lowest attractor found, is 0.59% . The overall cumulative average inaccuracy is 0.05%. No consideration has been made of the actual observed hadron mass inaccuracies.

In terms of energy inaccuracy, the cumulative average inaccuracy for the lowest attractor found is 3.66 MeV/c^2, which is only slightly larger than the down quark mass and so is fairly good.

Where the inaccuracy produces an estimated mass larger than the actual observed hadron mass, this may suggest that the binding energy required for that particle may be lower than the opposite case where the estimate is lower than the actual observed mass. Since there can be only integer numbers of LQL stack π_s, the closest integer has been taken, rather than the lowest adjacent integer, which, whilst enabling better accuracy, ignores potential different binding energy effects.

If there were no 'building block' LQL stack π_s present, the overall inaccuracy would be expected to be around half the estimated LQL stack π_s mass, here 37.69 MeV/c^2, so that the actual accuracy of 3.66 MeV/c^2 is less than 10% of that figure. This latter supports the LQL stack π_s hypothesis.

That achieved accuracy is also supportive of the hypothesised relationship between the smaller charged and larger charged quarks, that the former (d,s,b) are half the size of the latter (u,c,t). The lower mass u and d quark family members may not be so important in the overall mass estimates, but the relative sizes of the higher mass family members supports that charge-related mass-size effect.

The inferred mass of the bottom quark, and thus the top quark, is within reasonable bounds provided that the aligned stack meson framework is correct. However, the direct relationship between the two different rates of lepton and quark individual inflation axes has not yet been established.

XVII. CONCLUSION

Despite the hypothetical framework, that all hadron mass energy is due to the presence of loops, each of whose mass energies are constant once in a stack regardless of energy of interaction (other than relativistic effects), being speculative, the results are quite encouraging.

The accuracies achieved using rigorous definitions set by the pre-fermion framework, such as size-of-charge related mass effects – reversing the relative expected sizes of the quarks in the smallest family – and equal total inflationary effects on quark and lepton sizes, are quite good. The overall cumulative average accuracy for all hadron masses of 0.05% and mass energy cumulative average inaccuracy of 3.66 MeV/c^2 is only slightly larger than the estimated down quark mass.

The accuracy of the estimated baryon magnetic moments using the same PFH variable sizes produces cumulative inaccuracy of 19%, versus 16% for the QM Best. The PFH cumulative mass inaccuracy, for those baryons considered, is 0.85%, versus the QM Best of 0.09%. However, the least-squares figures provide a better measure and they produce for the mass PFH $3.4\ x10^{-5}$ and QM $4.7\ x10^{-6}$, and for the magnetic moments PFH $1.96\ x10^{-3}$ and QM $1.13\ x10^{-2}$. Thus overall, for both mass and magnetic moments inaccuracies, the least-squares comparison of inaccuracies is PFH $2.0\ x10^{-3}$ and QM $1.13\ x10^{-2}$. Thus the PFH inaccuracies across both properties are around one sixth those of the current best QM models.

So it is clear that across the two properties of mass and magnetic moment for those baryons considered in this paper, the PFH interpretation of hadrons as stacks, of aligned loops of meons and anti-meons, provides a better estimate of the observable experimental observations.

The pre-fermion hypothesis covered by this paper, and others, enables almost all of the main features of our universe to be explained and deserves to be more widely considered.

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Table 1

Composite least-squares estimates of particle masses and magnetic moments, with Quark Model comparisons

Particle	Quark Mass MeV/c^2	Quark Name	J- Spin	Charge q	Mass +spin-spin MeV/c2	Π^+	Π^0	Π_s	Magnetic Moment μ_N	Baryon J-spin	Spin-spin adjustment MeV/c2	Adjusted Mass MeV/c2	Observed Mass MeV/c2	PFH Difference MeV/c2	PFH Mass % Difference	PFH Least Squares
Proton	5.138	u	0.5	0.667	366.18	0	0	5	1.709	0.5	-47.587	945.198	938.272	-6.926	-0.74%	5.45E-05
	2.569	d	-0.5	-0.333	288.23	0	0	4	-1.086							
p^+	5.138	u	0.5	0.667	290.80	0	0	4	2.153							
Neutron	2.569	d	0.5	-0.333	262.93	0	1	2	1.190	0.5	-76.139	935.510	939.565	4.055	0.43%	1.86E-05
	5.138	u	-0.5	0.667	265.49	0	1	2	-2.358							
n^0	2.569	d	0.5	-0.333	407.09	2	0	2	-0.769							
Lambda	5.138	u	-0.5	0.667	492.51	3	0	1	-1.271	-0.5	-20.169	1111.645	1115.683	4.038	0.36%	1.31E-05
	2.569	d	-0.5	-0.333	345.77	1	1	1	1.810							
Λ^0	129.33	s	0.5	-0.333	273.37	0	0	2	-1.145							
Sigma+	5.138	u	0.5	0.667	427.02	1	1	2	1.466	0.5	-10.274	1190.303	1189.370	-0.933	-0.08%	6.15E-07
	5.138	u	0.5	0.667	287.45	0	1	2	2.178							
Σ^+	129.33	s	-0.5	-0.333	475.83	1	1	1	-1.315							
Sigma-	2.569	d	-0.5	-0.333	334.71	0	2	1	-0.935	0.5	-39.582	1206.266	1197.449	-8.817	-0.74%	5.42E-05
	2.569	d	0.5	-0.333	410.09	0	2	2	-1.526							
Σ^-	129.33	s	0.5	-0.333	461.47	0	2	1	1.356							
Xio	129.33	s	0.5	-0.333	204.45	0	0	1	-3.062	0.5	-0.771	1308.214	1314.860	6.646	0.51%	2.56E-05
	129.33	s	-0.5	-0.333	613.98	1	2	1	0.510							
Ξ^0	5.138	u	0.5	0.667	489.78	1	2	1	1.278							
Xi-	129.33	s	0.5	-0.333	489.94	0	1	3	-0.639	0.5	-1.527	1320.672	1321.710	1.038	0.08%	6.17E-07
	129.33	s	-0.5	-0.333	268.39	1	0	0	1.166							
Ξ^-	2.569	d	0.5	-0.333	562.34	1	2	2	-1.113							
Omega -	129.33	s	0.5	-0.333	408.49	2	0	0	-0.766	1.5	0.045	1655.357	1672.450	17.093	1.02%	1.04E-04
	129.33	s	0.5	-0.333	344.30	1	0	1	-0.909							
Ω^-	129.33	s	0.5	-0.333	902.58	5	0	1	-0.347							
															0.85%	3.40E-05
Variables				Average net quark sizes					Total Least-squares inaccuracy				PFH	2.00E-03		PFH
A	335	(MeV/c2)^3		Down	373.0221	MeV/c2							QM Best	1.13E-02		
d	2.569	MeV/c2		Up	374.1752	MeV/c2										
u	5.138	MeV/c2		Strange	444.2783	MeV/c2										
s	129.33	MeV/c2														
Π_s	75.38	MeV/c2														

Particle	QM Best Predicted MeV/c2	QM Best Difference MeV/c2	QM Best Mass % Difference	QM Best Least Squares	Total Charge q	Π^+	Π^0 Meson Totals	Π_s	PFH Magnetic Moment μ_N	Observed Magnetic Moment μ_N	PFH Moment Difference μ_N	PFH Moment % difference	QM Best Moment Predicted μ_N	QM Best Moment Difference μ_N	QM Best Moment % difference	PFH Least Squares	QM Best Least Squares
Proton	939	-0.73	-0.08%	6.02E-07	1	0	0	13	2.776	2.793	-0.017	-0.60%	2.79	-0.003	-0.10%	3.602E-05	1.039E-06
Neutron	939	0.57	0.06%	3.62E-07	0	2	2	6	-1.936	-1.913	-0.023	1.21%	-1.86	0.053	-2.77%	1.455E-04	7.688E-04
Lambda	1116	-0.32	-0.03%	8.07E-08	0	4	1	4	-0.606	-0.613	0.007	-1.22%	-0.61	0.003	-0.49%	1.480E-04	2.395E-05
Sigma+	1193	-3.63	-0.31%	9.31E-06	1	2	3	5	2.328	2.458	-0.130	-5.29%	2.68	0.222	9.03%	2.799E-03	8.157E-03
Sigma-	1193	4.45	0.37%	1.38E-05	-1	0	6	4	-1.105	-1.160	0.055	-4.74%	-1.09	0.070	-6.03%	2.247E-03	3.641E-03
Xio	1318	-3.14	-0.24%	5.70E-06	0	2	4	3	-1.274	-1.250	-0.024	1.91%	-1.44	-0.190	15.20%	3.629E-04	2.310E-02
Xi-	1318	3.71	0.28%	7.88E-06	-1	2	3	5	-0.586	-0.651	0.065	-9.97%	-0.51	0.141	-21.62%	9.949E-03	4.675E-02
Omega -	1672	0.45	0.03%	7.24E-08	-1	8	0	2	-2.022	-2.020	-0.002	0.10%	-1.84	0.180	-8.91%	9.406E-07	7.940E-03
	Least-squares inaccuracy			4.73E-06	0.09%								Least-squares inaccuracy			1.961E-03	1.130E-02
		MASS		QM Best									MAGNETIC MOMENT			PFH	QM Best
																-18.61%	-15.70%

Table 2

Sectional cumulative average inaccuracies

			%	MeV/c2
BARYONS-	u, d and s	$(J^p = 3/2)$	0.24%	3.33
BARYONS-	u, d and s	$(J^p = 1/2)$	0.11%	1.29
BARYONS-	u, d, s and c	$(J^p = 1/2, 3/2)$	0.00%	0.00
BARYONS-	u, d, s and b	$(J^p = 1/2)$	0.02%	1.06
BARYONS-	u, d, s and b	$(J^p = 3/2)$	0.21%	12.64
MESONS-	u,d and s	$(J^p = 0,1)$	-0.59%	-4.52
MESONS-	u, d, s, c and b	$(J^p = 0)$	0.31%	12.38
MESONS-	u, d, s, c and b	$(J^p = 1)$	0.08%	3.09
	Cumulative average inaccuracies		0.05%	3.66

Table 3

BARYONS- u, d and s ($J^p = 3/2$)

Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
Delta	Δ^-	ddd	1232	7.71	1110.08	4	3	1.95	2	9	-3.89	1235.9	-50.42%	-0.32%	-0.17%
Delta	Δ^{++}	uuu	1231	15.41	1187.03	4	3	2.97	3	10	-2.32	1233.3	-15.03%	-0.19%	
Delta	Δ^0	$(udd + dud)/\sqrt{2}$	1232	10.28	1145.58	4	2	4.21	4	10	15.83	1216.2	154.06%	1.28%	
Delta	Δ^+	$(uud + udu)/\sqrt{2}$	1232	12.85	1171.57	4	3	2.76	3	10	-17.78	1249.8	-138.44%	-1.44%	
Sigma	Σ^{*-}	sdd	1387.2	134.47	1213.15	4	3	3.32	3	10	23.80	1363.4	17.70%	1.72%	-0.36%
Sigma	Σ^{*0}	$(sud + sdu)/\sqrt{2}$	1383.7	137.04	1226.49	4	4	1.70	2	10	-22.45	1406.2	-16.38%	-1.62%	
Sigma	Σ^{*+}	suu	1382.8	139.61	1232.92	4	4	1.79	2	10	-16.03	1398.8	-11.48%	-1.16%	
Xi	Ξ^{*-}	ssd	1535	261.23	1272.24	4	4	2.31	2	10	23.30	1511.7	8.92%	1.52%	1.24%
Xi	Ξ^{*0}	ssu	1531.8	263.80	1267.23	4	4	2.24	2	10	18.28	1513.5	6.93%	1.19%	
Omega	Ω^-	sss	1672.45	387.99	1284.41	8	0	2.23	2	10	17.09	1655.4	4.41%	1.02%	

BARYONS- u, d and s ($J^p = 1/2$)

Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
Sigma	Σ^+	suu	1189.37	139.61	1060.04	2	3	4.99	5	10	-0.93	1190.3	-0.67%	-0.08%	0.20%
Sigma	Σ^0	$(sud + sdu)/\sqrt{2}$	1192.64	137.04	1075.77	2	3	5.20	5	10	14.80	1177.8	10.80%	1.24%	
Sigma	Σ^-	sdd	1197.45	134.47	1102.56	0	6	3.88	4	10	-8.82	1206.3	-6.56%	-0.74%	
Lambda	Λ^0	uds	1115.68	137.04	998.82	4	1	4.05	4	9	4.04	1111.6	2.95%	0.36%	
Xi	Ξ^-	ssd	1321.71	261.23	1062.01	2	3	5.01	5	10	1.04	1320.7	0.40%	0.08%	0.29%
Xio	Ξ^0	ssu	1314.86	263.80	1051.83	2	4	3.09	3	9	6.65	1308.2	2.52%	0.51%	
Proton	p^+	udu	938.27	12.85	973.01	0	0	12.91	13	13	-6.93	945.2	-53.92%	-0.74%	-0.15%
Neutron	n^0	dud	939.57	10.28	1005.43	2	2	6.05	6	10	4.05	935.5	39.46%	0.43%	

Table 3 (cont.)

BARYONS-	u, d, s and c	$(J^p = 1/2, 3/2)$													
Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
Lambda	Λ_c^+	udc	2286.46	266.37	2039.69			27.06	27		4.43	2282.0	1.66%	0.19%	0.19%
Eta	Σ_c^{++}	uuc	2453.97	268.94	2194.93			29.12	29		8.91	2445.1	3.31%	0.36%	-0.05%
Eta	Σ_c^+	udc	2452.9	266.37	2206.13			29.27	29		20.11	2432.8	7.55%	0.82%	
Eta	Σ_c^0	ddc	2453.75	263.80	2228.78			29.57	30		-32.62	2486.4	-12.37%	-1.33%	
Xi	Ξ_c^+	usc	2467.94	393.13	2075.39			27.53	28		-35.25	2503.2	-8.97%	-1.43%	-0.65%
Xi	Ξ_c^0	dsc	2470.9	390.56	2081.48			27.61	28		-29.16	2500.1	-7.47%	-1.18%	
Xi'	$\Xi_c'^+$	usc	2578.4	393.13	2184.70			28.98	29		-1.32	2579.7	-0.34%	-0.05%	
Xi'	$\Xi_c'^0$	dsc	2579.2	390.56	2187.50			29.02	29		1.48	2577.7	0.38%	0.06%	
Omega	Ω_c^0	ssc	2695.2	517.32	2177.85			28.89	29		-8.17	2703.4	-1.58%	-0.30%	-0.30%
Xi	Ξ_{cc}^{++}	ucc	3621.2	522.46	3098.74			41.11	41		8.16	3613.0	1.56%	0.23%	0.23%

BARYONS-	u, d, s and b	$(J^p = 1/2)$													
Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
Lambda	Λ_b^0	udb	5619.6	296.45	5342.69			70.88	71		-9.29	5628.9	-3.13%	-0.17%	0.02%
Xi	Ξ_b^0	usb	5791.9	296.45	5496.00			72.91	73		-6.74	5798.6	-2.27%	-0.12%	
Xi	Ξ_b^-	dsb	5797	420.64	5377.46			71.34	71		25.48	5771.5	6.06%	0.44%	
Simga	Σ_b^+	uub	5810.56	299.02	5521.40			73.25	73		18.66	5791.9	6.24%	0.32%	
Sigma	Σ_b^-	ddb	5815.64	293.88	5560.50			73.77	74		-17.62	5833.3	-5.99%	-0.30%	
Sigma	Ω_b^-	ssb	6046.1	547.40	5498.72			72.95	73		-4.02	6050.1	-0.73%	-0.07%	

BARYONS-	u, d, s and b	$(J^p = 3/2)$													
Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
Simga	Σ_b^+	uub	5830.32	299.02	5521.44			73.25	73		18.70	5811.6	6.25%	0.32%	0.21%
Sigma	Σ_b^-	ddb	5834.74	293.88	5502.11			72.99	73		-0.63	5835.4	-0.21%	-0.01%	
Xi	Ξ_b^0	usb	5952.30	296.45	5655.29			75.02	75		1.79	5950.5	0.61%	0.03%	
Xi	Ξ_b^-	dsb	5955.33	420.64	5533.58			73.41	73		30.84	5924.5	7.33%	0.52%	

Table 4

MESONS-	u,d and s	$(J^p = 0,1)$													
Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
Pion	Π^+	ud^+	139.57	7.71	150.90	0	0	2.00	2	0	0.138	139.4	1.79%	0.10%	0.16%
Pion	Π^0	$(uu^- - dd^+)/\sqrt{2}$	134.98	7.71	151.06	0	0	2.00	2	0	0.303	134.7	3.93%	0.22%	
Eta	η	$(uu^- + dd^+ - 2ss^+)/\sqrt{6}$	547.86	137.04	418.77	0	2	1.97	2	4	-1.95	549.8	-1.42%	-0.36%	-0.43%
Eta'	η'	$(uu^- + dd^+ + ss^+)/\sqrt{3}$	957.78	137.04	836.61	0	4	3.94	4	8	-4.82	962.6	-3.51%	-0.50%	
Kaon	K^+	us^+	493.68	134.47	359.59	0	1	2.98	3	4	-1.53	495.2	-1.14%	-0.31%	0.38%
Kaon	K^0	ds^+	497.61	131.90	366.47	0	1	3.07	3	4	5.35	492.3	4.06%	1.08%	
Phi	Φ^0	ss^+	1019.46	258.66	760.80	2	2	2.81	3	7	-14.44	1033.9	-5.58%	-1.42%	-1.42%
Kaon*	K^{*+}	us^+	891.66	134.47	757.07	2	2	2.76	3	7	-18.17	909.8	-13.51%	-2.04%	-1.15%
Kaon*	K^{*0}	ds^+	895.81	131.90	763.66	0	4	2.97	3	7	-2.39	898.2	-1.81%	-0.27%	
Rho	ρ^+	ud^+	775.11	7.71	761.06	2	2	2.81	3	7	-14.18	789.3	-183.93%	-1.83%	-1.10%
Rho	ρ^0	$(uu^- - dd^+)/\sqrt{2}$	775.26	7.71	761.21	0	4	2.94	3	7	-4.84	780.1	-62.78%	-0.62%	
Omega	ω	$(uu^- + dd^+)/\sqrt{2}$	782.65	7.71	768.60	2	2	2.91	3	7	-6.64	789.3	-86.10%	-0.85%	

MESONS-	u, d, s, c and b	$(J^p = 0)$													
Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
D	D^0	cu^-	1864.84	263.80	1601.23			21.24	21		18.25	1846.6	6.92%	0.98%	0.31%
D	D^+	cd^+	1869.61	261.23	1608.76			21.34	21		25.78	1843.8	9.87%	1.38%	
D	D_s^+	cs^+	1968.3	387.99	1580.32			20.96	21		-2.66	1971.0	-0.69%	-0.14%	
B	B^+	ub^+	5279.26	293.88	4985.55			66.14	66		10.47	5268.8	3.56%	0.20%	
B	B^0	db^+	5279.58	291.31	4988.61			66.18	66		13.53	5266.1	4.64%	0.26%	
B	B_s^0	sb^+	5366.77	418.07	4948.70			65.65	66		-26.38	5393.1	-6.31%	-0.49%	
B	B_c^+	cb^+	6275.6	547.40	5728.20			75.99	76		-0.68	6276.3	-0.12%	-0.01%	

Table 4 (cont.)

MESONS-	u, d, s, c and b $(J^p = 1)$															
Particle Name	Particle Symbol	Quark Content	Observed Mass (MeV/c2)	Quarks Mass (MeV/c2)	Remainder Mass (MeV/c2)	Independent Pions Π^+	Π^0	Stack Meson Content	Stack Core Π_s	Total Mesons	Mass Inaccuracy (MeV/c2)	Estimated Mass (MeV/c2)	Fractional Quark Content %	Fractional Hadron Content %	Average Accuracy Hadron %
D	D^{*0}	cu^-	2006.96	263.80	1743.10			23.12	23		9.36	1997.6	3.55%	0.47%	0.08%
D	D^{*+}	cd^+	2010.26	261.23	1748.90			23.20	23		15.16	1995.1	5.81%	0.75%	
D	D_s^{*+}	cs^+	2112.1	387.99	1724.11			22.87	23		-9.63	2121.7	-2.48%	-0.46%	
B	B^{*+}	ub^+	5325.2	293.88	5031.26			66.75	67		-19.20	5344.4	-6.53%	-0.36%	
B	B^{*0}	db^+	5325.2	291.31	5033.77			66.78	67		-16.69	5341.9	-5.73%	-0.31%	
B	B_s^{*0}	sb^+	5415.4	418.07	4997.32			66.30	66		22.24	5393.2	5.32%	0.41%	

Table 5

How total stack mesons and core stack Π_s numbers change due to J^p spin and charm (First number is mode if alternates exist)

Baryons - Stack Meson total/core numbers

Particle	*Jspin ½*	*Jspin 3/2*	*Charmed*	*Double Charmed*	*2Qaverage*
p^+	13/13				1
n^0	10/6				0
Λ^0	9/4		27		0
$\sum$	10/5		29		0
Ξ	10/5		28		-1
Δ		10/3			1
$\sum^*$		10/2			0
Ξ^*		10/2		41	-1
ω		10/2	29		-2

Table 6

Mesons - Stack Meson total/core Π_s numbers

Particle	*Jspin 0*	*Jspin 1*	*2Qaverage*
Π	2/2		0
K^+	4/3		+1
K^-	4/3		-1
η	4/2		0
η'	8/4		0
D	21		
B	66		
K^{*+}		7/3	+1
ρ		7/3	0
K^{*-}		7/3	-1
Φ		7/3	0
ω		7/3	0
D^*		23	
B^*		67	

Table 7

Baryons - Stack Meson total/core Π_s numbers with bottom content

Particle	*Jspin ½*	*Jspin 3/2*	*2Qaverage*
Λ_b^0	71		0
$\sum_b$	73	73	0
Ξ_b	73	73	-1
ω_b	73		-2

Table 8

Octet and decuplet replacements

Baryons

Anti-matter set $(J^p = 3/2)$

s quark content ↓ \ *d quark content*	**3**	**2**	**1**	**0**
0	Δ^-	Δ^0	$\underline{\Delta^+}$	$\underline{\Delta^{++}}$
1		Σ^{*-}	Σ^{*0}	$\underline{\Sigma^{*+}}$
2			Ξ^{*-}	Ξ^{*0}
3				Ω^-

N.B> Antiparticle of Xa is $\underline{Xa}$

Baryons

Matter set $(J^p = 3/2)$

$\underline{s}$ quark content ↓ \ *$\underline{d}$ quark content*	**3**	**2**	**1**	**0**
0	$\underline{\Delta^-}$	$\underline{\Delta^0}$	Δ^+	Δ^{++}
1		$\underline{\Sigma^{*-}}$	$\underline{\Sigma^{*0}}$	Σ^{*+}
2			$\underline{\Xi^{*-}}$	$\underline{\Xi^{*0}}$
3				$\underline{\Omega^-}$

N.B> Antiparticle of Xa is $\underline{Xa}$

Baryons

Anti-matter set $(J^p = 1/2)$

s quark content ↓ \ *d quark content*	**3**	**2**	**1**	**0**
0	**A**	n^0	$\underline{p^+}$	**B**
1		Σ^-	$\Sigma^0 \Lambda^0$	$\underline{\Sigma^+}$
2			Ξ^-	Ξ^0
3				**C**

N.B> Antiparticle of Xa is $\underline{Xa}$

Baryons

Matter set $(J^p = 1/2)$

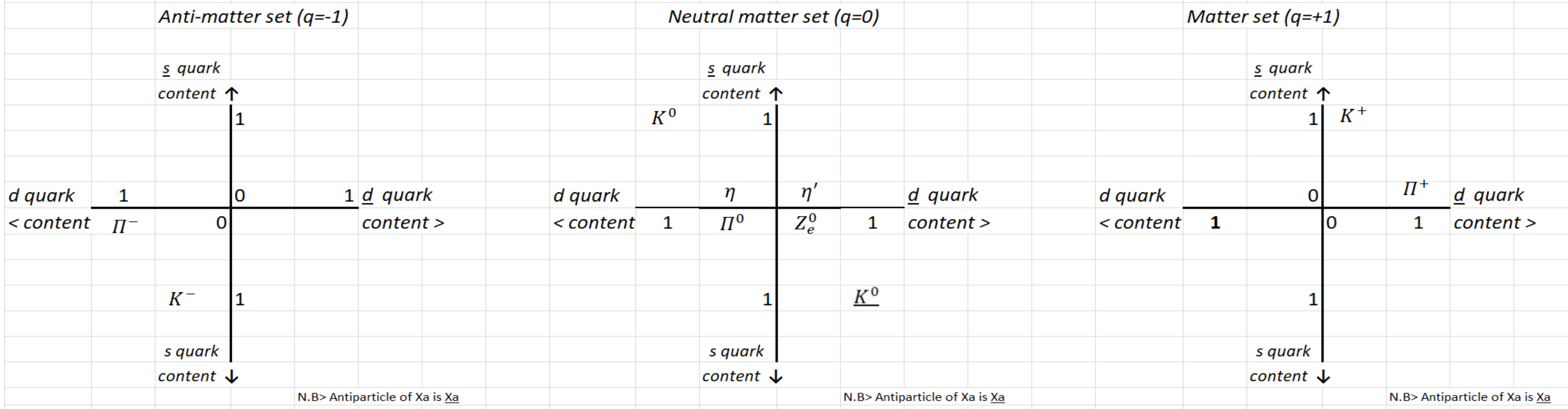
$\underline{s}$ quark content ↓ \ *$\underline{d}$ quark content*	**3**	**2**	**1**	**0**
0	$\underline{\mathbf{A}}$	$\underline{n^0}$	p^+	$\underline{\mathbf{B}}$
1		$\underline{\Sigma^-}$	$\underline{\Sigma^0 \Lambda^0}$	Σ^+
2			$\underline{\Xi^-}$	$\underline{\Xi^0}$
3				$\underline{\mathbf{C}}$

N.B> Antiparticle of Xa is $\underline{Xa}$

Table 8 (cont.)

Nonet replacements

Mesons $(J^P = 0)$



Mesons $(J^P = 1)$