On the *Binary Nature* of *Triad Structures* in *Subatomic Entities*

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... for Vivan...

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1.1 Harmonics, Spectrum and Energy:

The history of Quantum Levels of Energy are likely older than Pythagoras – at least equally old if Pythagoras in fact discovered Overtones, Harmonics and Scales in vibrating strings and sounding columns. 2500 years later, Balmer revealed *Squared Harmonic Spectrum* (n^{-2}) in the Atoms – which Bohr explained later around 1913 by Orbiting Electrons around a central Nucleus.

The Harmonic Sequence for the vibrating string is equivalent to the Natural Numbers – so it's Domain can't be more fundamental – and in fact defines the raw materials in every musical scale – whatever geographical location.

To emphasize the ancient origin of quantum energy levels – it is illustrative and informative to enumerate the first 16 harmonic frequencies of the plucked string. We do this by drawing up a table with 16 rows and the following columns: Harmonic Index, Name of Interval, Note, Degeneracy, Musical Scale, Fraction, Decimal, Equally Tempered Scale, Decimal and the difference in percents of the current ETS to the ancient Harmonic Scale of Pythagoras.

Harmon.	Name	Note	Degen.	Scale	Fraction	Decim.	ETS	Decim.	%
1	Fundamental	C	5	1	1	1.000	0	1.0000	0
2	Octave	C	5	1	1	1.000	0	1.0000	0
3	Fifth	G	3	5	3/2	1.500	7	1.4983	0.11
4	Octave	C	5	1	1	1.000	0	1.0000	0
5	Third	E	2	3	5/4	1.250	4	1.2599	0.8
6	Fifth	G	3	5	3/2	1.500	7	1.4983	0.11
7	Minor Seventh	B	2	7^-	7/4	1.750	10	1.7818	1.8
8	Octave	C	5	1	1	1.000	0	1.0000	0
9	Ninth	D	1	2	9/8	1.125	2	1.1225	0.23
10	Third	E	2	3	5/4	1.250	4	1.2599	0.80
11	Fourth	F	1	4	11/8	1.375	5	1.3348	3
12	Fifth	G	3	5	3/2	1.500	7	1.4983	0.11
13	Sixth	A	1	6	13/8	1.625	9	1.6818	3.5
14	Minor Seventh	B	2	7^-	7/4	1.750	10	1.7818	1.8
15	Major Seventh	H	1	7^+	15/8	1.875	11	1.8877	0.68
16	Octave	C	5	1	1	1.000	0	1.0000	0

TABLE I

The 1st Octave has one member, the 2nd Octave has 2 members, the 3rd Octave has 4 members and the 4th Octave has 8 members. Further – every Octave includes the one below. Some interesting "discrepancies" appear – such as the Fifth being the 3rd Harmonic and the Third being the 5th Harmonic!

The 4th Octave in Table ***1*** enumerates all members sequentially and will be the choice as the most natural index with the Scale equal to the Harmonic index. In the 4th Octave there are 4 unique members *{9, 11, 13, 15}*. The 11th harmonic is logarithmically central in the natural 4th Octave (8-11-15) and is the cleanest resonance that could be sustained. Harmonic number 15 is unique but divisible by both 3 and 5, and Harmonic 9 has similar property, which makes the 11th Harmonic even more unique.

1.2 *Triad* Structures in the Nucleus:

The so-called Magic Number Sequence *{2, 8, 20, 28, 50, 82, 126}* of anomalously energetic nucleuses, such as Helium (2+2), Oxygen (8+8) and Calcium (20+20) - offers a new support to the *Triad* nature of sub-atomic and sub-nuclear structures. The Magic Number Sequence is very different from the atomic sequence of orbiting electron - which is *{2, 8, 18, 32}* – reflecting the complete shell of orbiting electrons in a sub-shell sequence of *{2, 6, 10, 14}* corresponding to the *{S, P, D, F}* electron levels in an atom.

The first hypothesis on the road to Magic Number reduction – is a geometric observation that different packing strategy holds for few entities versus many entities. If we take the "few" *{2, 8, 20}* to adhere to different packing strategy - than the remaining "many" *{28, 50, 82, 126}*, we obtain the following expressions where $A(n)$ is the particular *Magic Number* of index n:

$$A(n) = \begin{cases} 3 \cdot n^2 - 3 \cdot n + 2 & 1 \le n \le 3 \\ \frac{1}{3} \cdot n^3 + \frac{5}{3} \cdot n & 4 \le n \end{cases}$$

The *Triad* nature is preserved in both expressions, either as 3 or 1/3 – although different expression could apply for still heavier unseen nucleuses. The first three Magic Numbers coincide with the Triangle, Octahedron and Icosahedron in the sequence of the Extended Platonic Structures. The Magic Numbers are in boldface:

Edges:	***Vertexes:***	***Faces:***	***Name:***	***Polygon:***
-	*1*	*-*	*Node*	*-*
-	***2***	*-*	*Segment*	*-*
3	*3*	***2***	*Triangle*	*Triangle*
6	*4*	*4*	*Tetrahedron*	*Triangle*
12	***8***	*6*	*Cube*	*Rectangle*
12	*6*	***8***	*Octahedron*	*Triangle*
24	*14*	*12*	*Dodecahedron*	*Diamond (or rhombic)*
24	*12*	*14*	*Vector Equilibrium*	*Triangle / Rectangle*
30	***20***	*12*	*Dodecahedron*	*Pentagon*
30	*12*	***20***	*Icosahedron*	*Triangle*

TABLE II

The Icosahedron is dual to the Dodecahedron and the Octahedron is dual to the Cube – and both pairs reveal a Magic Number in faces *(F)* or vertexes *(V)*. To complete, the Vector Equilibrium is dual to the Rhombic Dodecahedron, the Tetrahedron is its own dual and the Triangle is semi-dual to the Segment.

The Platonic Solids can now explain the "break" in the Magic Number sequence, where spherical packing takes over - the first three Magic Numbers *{2, 8, 20}* yield to the Platonic Solids - while the remaining *{28, 50, 82, 126}* respect spherical packing.

In this paper, we use the collective behaviour of few Nucleons to gain insight into the internal structures. The magic solids have Edges and Vertexes divisible by *three* and have *Triangular* Faces, which both support the asserted internal *Triad* nature of the Nucleons – both Protons and Neutrons.

1.3 Continued Fractions as an Inspective Tool:

To gain deeper insight into either rationality, or the transcendental character of real numbers encountered in the Subatomic realms, continued fraction expansion can reveal order or chaos in numbers such as π, e $\sqrt{2}$ and $\sqrt{3}$. The most simple continued fractions seems to be square roots, which have beautiful expansion – almost too good to be true:

$$\sqrt{2}=1+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cfrac{1}{2+\cdots}}}}}}}}}$$

We immediately see that the number $(\sqrt{2}-1)$ is very simple with the whole number (2) repeated infinitely – and the same applies to the number $(\sqrt{3}-1)$ which has a repeated pattern of $(1,2)$:

$$\sqrt{3}=1+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cfrac{1}{2+\cfrac{1}{1+\cdots}}}}}}}}}$$

We soon need to define a shorthand notation for continued fractions and special shorthand for repeated patterns – as the continued fractions are very space consuming. We suggest using the Greek letter Φ for Fraction, with subscript to indicate repeated sequences. We can express the square root of two as $\sqrt{2} = 1+\Phi_1(2)$ and the square root of three as $\sqrt{3} = 1+\Phi_2(1,2)$. Armed with this notation – we go right ahead and enumerate the first few square roots to get familiar with the patterns and sequences that manifest:

$\sqrt{2} = 1+\Phi_1(2)$	$\sqrt{3} = 1+\Phi_2(1,2)$	$\sqrt{5} = 2+\Phi_1(4)$	$\sqrt{6} = 2+\Phi_2(2,4)$
$\sqrt{7} = 2+\Phi_4(1,1,1,4)$	$\sqrt{8} = 2+\Phi_2(1,4)$	$\sqrt{10} = 3+\Phi_1(6)$	$\sqrt{11} = 3+\Phi_2(3,6)$

The Golden Ratio has the simplest Continued Fraction expansion: $\phi = \Phi_1(1)$, with only "ones", but is in fact the most irrational number in the square root family, as it converges slowest.

1.4 Continued Fractions and transcendental numbers:

The continued fraction is a valuable tool to inspect numbers for algebraic content, that is rationality or transcendental character. We have seen how the square root yields to continued fraction expansion in an impressive way – and continued fraction expansion for π and e will reveal the presently unknown fact (or little known fact) that π is more transcendental than e. This is demonstrated with the new shorthand Φ-notation as:

$$e = 1 + \Phi_\infty(1,1,2,1,1,4,1,1,6,1,1,8,1,1,10,\cdots) = 1 + \Phi_3(1,1,2\cdot k)$$

$$\pi = 3 + \Phi_\infty(7,15,1,292,1,1,1,1,2,1,\cdots) = \Phi_\infty(0,3,7,15,1,292,1,1,1,2,\cdots)$$

We see from the above, that e is simpler than π - and we need a more complex algorithm to compute π. At this stage it will be necessary to recall the analytical definition of e and π:

$$e = \lim_{n\to\infty}\left(1+\tfrac{1}{n}\right)^n = 1+\tfrac{1}{2}+\tfrac{1}{6}+\tfrac{1}{24}+\tfrac{1}{120}+\cdots+\tfrac{1}{k!}+\cdots = \sum_{k=1}^{\infty}\tfrac{1}{k!}$$

$$\pi = 2\cdot\prod_{k=1}^{\infty}\tfrac{4\cdot k^2}{4\cdot k^2-1} = 4\cdot\left(1-\tfrac{1}{3}+\tfrac{1}{5}-\tfrac{1}{7}+\tfrac{1}{9}-\cdots+\tfrac{(-1)^{k-1}}{2k-1}+\cdots\right) = 4\cdot\sum_{k=1}^{\infty}\tfrac{(-1)^{k-1}}{2k-1}$$

These expressions indeed confirm that the number e – the "natural base of logarithm" – is much simpler – than the "circular" number π – in both the multiplicative and the additive expression. I now conclude, that as e has a 'simple' algorithm in Additive, Multiplicative and Continued Fraction it's a 'simple' algebraic object. On the other hand, π can't be reduced to a repeated continued fraction like e does.

1.5 Magnetic Moment of the Proton:

In Section ***9.1*** the magnetic moment is shown to be the square root of a rational number – expressing the cyclic currents constituting the particular Baryon. The Proton has a regular pattern in its magnetic moment as revealed in the expression:

$$\mu_p = 2 + \Phi_\infty(1,3,1,4,1,3,1,4,2,2,3,1,1,\cdots) \approx 2 + 1/\Phi_4(1,3,1,4)$$

To test for "square root ness" – let us expand the squared magnetic moment $(\mu_p)^2$ into a continued fraction:

$$(\mu_p)^2 = 7 + \Phi_\infty(1,3,1,10659,1,1,2,1,2,5,\cdots) \approx 7 + \Phi_0(1,3,1)$$

When we encounter a rational number, the continued fraction expansion will terminate with infinity – that is – a rational numbers has a finite continued fraction expansion.

1.6 Heuristic mass calculation for the Proton, Neutron and Sigma:

Expansion into continued fraction can serves the purpose to weigh sub-nuclear entities against each other. This indeed revealed rational masses of subatomic entities as discovered by the author back in 1997-2000. The most striking case was the mass of the Proton and Neutron. Instrumental in this was the "Fine Structure Constant" introduced later in Section ***2.1***:

$$\alpha^2 \cdot \left(\frac{m_{p,n}}{m_e}\right) = \cfrac{1}{10 + \cfrac{1}{4 + \cfrac{1}{2 + \cfrac{1}{2}}}} = \frac{22}{15^2} \qquad , \qquad \alpha^2 \cdot \left(\frac{m_{\Sigma}}{m_e}\right) = \cfrac{1}{8 + \cfrac{1}{15}} = \frac{15}{11^2}$$

The CF sequence [10, 4, 2, 2] for the nucleons has a structural and dynamical source, which will reveal the composition of the proton/neutron entity. The Sigma sequence [8, 15] is short terminating after two terms. Now depicture the proton in its most symmetrical representation $p = udu$ with each quark, Up or Down, expressed from fundamental entities o & k, defined in Section ***2.6***, where k is charged but o uncharged. This decomposition gives the Proton a total of five k*'s* and a four fundamental o*'s* entities:

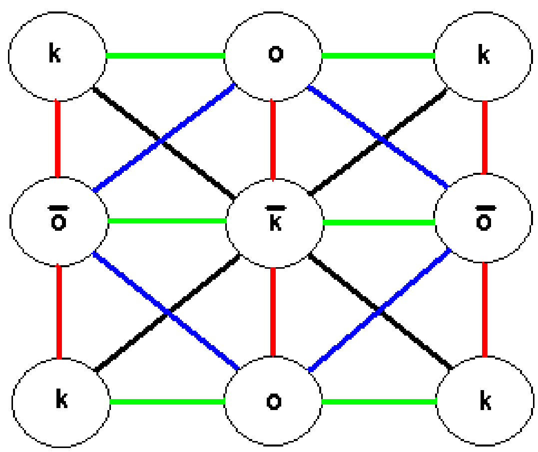


FIGURE III

The k entities have 5 different permutations – while the o entities have 6 different permutations which gives additive degeneracy of 5+6=11 but multiplicative degeneracy of 5x6 = 30 which seems to harmonize with the Nucleon fraction $22/15^2$ and the Sigma fraction $15/11^2$ - and also the Delta fraction 5/39 and the Omega fraction 23/132 evaluated in Section ***4.2*** and ***4.3***:

$$\alpha^2 \cdot \left(\frac{m_N}{m_e}\right) = \frac{11+11}{(11+4)^2} = \frac{22}{15^2} \qquad , \qquad \alpha^2 \cdot \left(\frac{m_{\Sigma}}{m_e}\right) = \frac{11+4}{11^2} = \frac{15}{11^2}$$

$$\alpha^2 \cdot \left(\frac{m_{\Delta}}{m_e}\right) = \frac{11+4}{11^2 - 4} = \frac{5}{39} \qquad , \qquad \alpha^2 \cdot \left(\frac{m_{\Omega}}{m_e}\right) = \frac{11+11+1}{11^2 + 11} = \frac{23}{132}$$

2.1 The Fine Structure of the Electron:

The Fine Structure Constant *Alpha* (α) relates the *Coulomb Radius* r_e, the *Compton Radius* r_γ and the *Rydberg Radius* r_R for an Electron – and can be evaluated from the Electrons-Charge e <u>and</u> Planck's quantum of action h <u>and</u> the Speed of Light c in vacuum <u>and</u> either the Permittivity ε_0 or the Permeability μ_0 of vacuum:

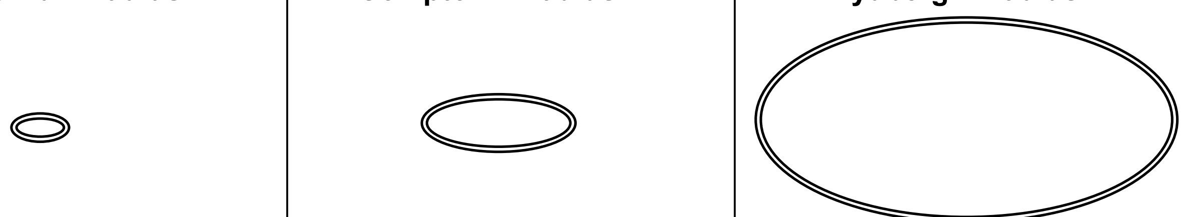
$$\alpha = \frac{e^2}{2\cdot\varepsilon_0\cdot h\cdot c} = \frac{c\cdot\mu_0\cdot e^2}{2\cdot h} = \frac{\pi\cdot c\cdot e^2}{5\cdot 10^6\cdot h} = \frac{c\cdot e^2}{10^7\cdot\hbar} = \cdots = \frac{N_0^{\ 4}}{4!}\cdot\left(\frac{m_e}{m_{Plank}}\right)^2 \qquad (1.1.1)$$

The last equality in Equation ***1*** is from this authors 1998 discovery *[ref. 4]* of the "Rational Newton-Coulomb Ratio" which uses $N_0 = 10^{11}$ as a scaling integer and m_{Plank} as the *Plank Mass*. The three radii $\{r_e, r_\gamma, r_R\}$ yield to the geometric sequence $\{\alpha, 1, 1/\alpha\}$:

$$r_e = \frac{e^2}{4\cdot\pi\cdot\varepsilon_0\cdot m_e\cdot c^2} = \frac{\hbar}{m_e\cdot c}\cdot\alpha = r_\gamma\cdot\alpha$$
$$r_\gamma = \frac{h}{2\cdot\pi\cdot m_e\cdot c} = r_e\cdot\alpha^{-1} = r_R\cdot\alpha$$
$$r_R = \frac{\varepsilon_0\cdot h^2}{\pi\cdot m_e\cdot e^2} = r_e\cdot\alpha^{-2} = r_\gamma\cdot\alpha^{-1}$$

The Compton Radius is a de Broglie Radius for light. To simplify the algebra let's define $f_\gamma = c/\lambda_\gamma = m_e c^2 / h$ as the *Mass Equivalent Frequency* of the Electron and picture three rings traced out by the Electron charge with magnitude e:

Coulomb – Radius:	**Compton – Radius:**	**Rydberg – Radius:**



$r_e = r_\gamma\cdot\alpha \approx 2.81\cdot 10^{-15}[m]$	$r_\gamma = c/2\pi\cdot f_\gamma \approx 3.86\cdot 10^{-13}[m]$	$r_R = r_\gamma\cdot\alpha^{-1} \approx 5.29\cdot 10^{-11}[m]$
$v_e = c\cdot\alpha^{-1} \approx 4.11\cdot 10^{10}[m/s]$	$v_\gamma = c \approx 3.00\cdot 10^8[m/s]$	$v_R = c\cdot\alpha \approx 2.18\cdot 10^6[m/s]$
$f_e = f_\gamma\cdot\alpha^{-2} \approx 2.32\cdot 10^{24}[Hz]$	$f_\gamma = m_e\cdot c^2/h \approx 1.23\cdot 10^{20}[Hz]$	$f_R = f_\gamma\cdot\alpha^2 \approx 6.58\cdot 10^{15}[Hz]$
$t_e = t_\gamma\cdot\alpha^2 \approx 4.31\cdot 10^{-25}[s]$	$t_\gamma = 1/f_\gamma \approx 8.09\cdot 10^{-21}[s]$	$t_R = t_\gamma\cdot\alpha^{-2} \approx 1.51\cdot 10^{-16}[s]$
$E_b = E_e\cdot\frac{1}{2}\cdot\alpha^{-2} \approx 4.80[GeV]$	$E_e = h\cdot f_\gamma \approx 511[KeV]$	$E_R = E_e\cdot\frac{1}{2}\cdot\alpha^2 \approx 13.6[eV]$

FIGURE I

The Rydberg Radius r_R is used here, rather than the Bohr Radius r_B because the "reduced mass" can always be calculated for any particular nucleus. Also all equations above apply in "Relativity" as the magnetic field is orthogonal to the current loops.

2.2 The Fine Structure in Electrons, Muons and Tauons:

As seen in Section ***2.1***, the Fine Structure *Alpha* α, in integer powers, is the geometric ratio of any consecutive pair in the sequence: *Coulomb Radius* r_e, *Compton Radius* $r_\gamma = r_e\ \alpha^{-1}$ and the *Rydberg Radius* $r_R = r_e\ \alpha^{-2}$. The Leptons can be weighed against the Electron mass m_e with the following convergent series for the mass of the Muon μ and the Tauon τ:

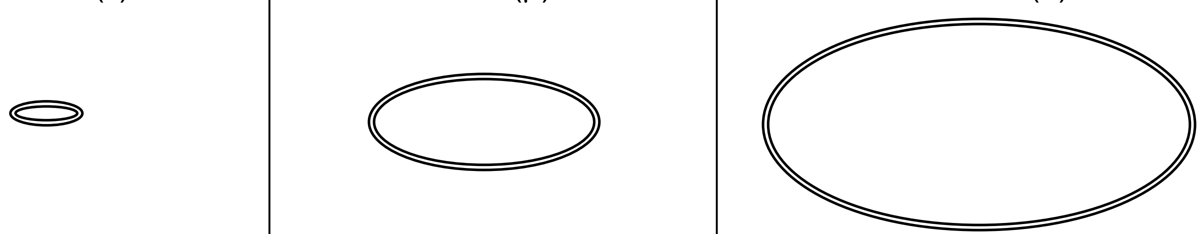
$$m_e = \alpha \cdot \left(\frac{\hbar}{r_e \cdot c} \right)$$

$$m_\mu = \frac{3}{2} \cdot \left(\frac{\hbar}{r_e \cdot c} \right) \cdot \left(1 + \tfrac{5\cdot\alpha}{2\pi} + 3 \cdot \left(\tfrac{5\cdot\alpha}{2\pi} \right)^2 - \tfrac{19}{4} \cdot \left(\tfrac{5\cdot\alpha}{2\pi} \right)^3 \cdots \right) = \left(\frac{7}{6!} \right) \cdot \frac{m_e}{11^2 \cdot \alpha^3}$$

$$m_\tau = \frac{5}{27 \cdot \alpha} \cdot \left(\frac{\hbar}{r_e \cdot c} \right) \cdot \left(1 + \tfrac{4}{5} \cdot \left(\tfrac{3\cdot\alpha}{2\pi} \right)^2 + 17 \cdot \left(\tfrac{5\cdot\alpha}{2\pi} \right)^3 \cdots \right) = \left(\frac{6}{5!} \right) \cdot \frac{m_e}{37 \cdot \alpha^3}$$

The multiplier and α-exponent reveal the two sequences {*1, 3/2, 5/27*} and {*1, 0, -1*} respectively. The 2nd equalities for the Muon and the Tauon mass are derived in Section ***8.2***. We can depicture the three leptons as an electromagnetic current loop which decreases in size with mass *r ~ 1/m*:

Tauon (τ)	Muon (μ)	Electron (e)



Tauon (τ)	Muon (μ)	Electron (e)
$m_\tau = 3477.6 \cdot m_e$	$m_\mu = 206.76826 \cdot m_e$	$m_e = 1 \cdot m_e$
$E_\tau = 1.777 [GeV]$	$E_\mu = 105.65835 [MeV]$	$E_e = 510.99890 [KeV]$
$r_\tau = 8.1032111 \cdot 10^{-19} [m]$	$r_\mu = 1.3628495 \cdot 10^{-17} [m]$	$r_e = 2.81794028 \cdot 10^{-15} [m]$
$g_\tau \approx 2.0$	$g_\mu = 2.002331832$	$g_e = 2.0023193043737$
$\tau_\tau \approx 0.29 \cdot 10^{-12} [s]$	$\tau_\mu = 2.1970 \cdot 10^{-6} [s]$	$\tau_e > 4.2 \cdot 10^{24} [years]$

FIGURE II

The Leptons {*e, μ, τ*} also possess a magnetic dipole moment expressed by the (Landé) g-factor or the bare magnetron itself:

$$\mu_e = (e\hbar / 2m_e) \cdot \left(1 + \tfrac{\alpha}{2\pi} - \tfrac{43}{33} \cdot \left(\tfrac{\alpha}{2\pi} \right)^2 + 45 \cdot \left(\tfrac{\alpha}{2\pi} \right)^4 \cdots \right)$$

$$\mu_\mu = (e\hbar / 2m_\mu) \cdot \left(1 + \tfrac{\alpha}{2\pi} + \tfrac{10}{3} \cdot \left(\tfrac{\alpha}{2\pi} \right)^2 + \tfrac{32}{5} \cdot \left(\tfrac{\alpha}{2\pi} \right)^3 \cdots \right)$$

$$\mu_\tau = (e\hbar / 2m_\tau) \cdot \left(1 + \tfrac{\alpha}{2\pi} \pm \cdots \right)$$

The Magnetic Moment of Leptons is thus very regular, with *(1+α/2π)* as the main contribution. The geometry is present here with π and α united in expressions and power series.

2.3 Computing the mass of Quarks with Fundamental Entities:

The hitherto unexplained mass asymmetry among the quarks reveal a light Up quark among heavy Charm and Top quarks – but a heavy Down quark among light Strange and Bottom quarks. By a new classification into "light" and "heavy" quarks, a simple recursive relationship was discovered for the different quark generations: $m_d = \alpha\, m_c$ and $m_c = \alpha\, m_t$ for the Down, Charm and Top quarks – and: $m_u = 3\alpha\, m_s$ and $m_s = 3\alpha\, m_b$ for the Up, Strange and Bottom quarks, where the Fine Structure Constant α is the mass-scaling factor:

$Top:$	$Charm:$	$Down:$	$Fundament:$
$uu\bar{u}$	$du\bar{d}$	$\bar{o}\bar{k}\bar{o}$	k
$\frac{m_c}{m_t} = \alpha$	$\frac{m_d}{m_c} = \alpha$	$\frac{m_k}{m_d} = \alpha$	$\frac{m_e}{m_k} = \frac{1}{2}\cdot(9\cdot\alpha)^{-1}$
$Bottom:$	$Strange:$	$Up:$	$Fundament:$
$dd\bar{d}$	$ud\bar{u}$	kok	o
$\frac{m_s}{m_b} = 3\cdot\alpha$	$\frac{m_u}{m_s} = 3\cdot\alpha$	$\frac{m_o}{m_u} = 3\cdot\alpha$	$\frac{m_e}{m_o} = \frac{2}{3}\cdot(9\cdot\alpha)^{-1}$

TABLE III

Each entry in Table ***3*** has two details, a *mass ratio* and *configuration triad*, the subject of Section ***3.1*** & ***3.3***, and explains the similarity of Charm and Down quarks – and the similarity of Strange and Up quarks. To complete, the Top and Charm quarks are also similar having an Up quark residue – while Bottom and Strange are similar having a Down quark residue. In this context we see that *{o, u, s, b}* and *{k, d, c, t}* constitutes a pair of sequences. By expanding the mass relations, we get:

$$m_d = \tfrac{1}{\alpha}\cdot m_k = 18\cdot m_e \qquad m_u = \tfrac{1}{3\cdot\alpha}\cdot m_o = \tfrac{9}{2}\cdot m_e$$

$$m_c = \tfrac{1}{\alpha}\cdot m_d = \tfrac{1}{\alpha^2}\cdot m_k = \tfrac{18}{\alpha}\cdot m_e \qquad m_s = \tfrac{1}{3\cdot\alpha}\cdot m_u = \tfrac{1}{9\cdot\alpha^2}\cdot m_o = \tfrac{3}{2\cdot\alpha}\cdot m_e$$

$$m_t = \tfrac{1}{\alpha}\cdot m_c = \tfrac{1}{\alpha^2}\cdot m_d = \tfrac{1}{\alpha^3}\cdot m_k = \tfrac{18}{\alpha^2}\cdot m_e \qquad m_b = \tfrac{1}{3\cdot\alpha}\cdot m_s = \tfrac{1}{9\cdot\alpha^2}\cdot m_u = \tfrac{1}{27\cdot\alpha^3}\cdot m_o = \tfrac{1}{2\cdot\alpha^2}\cdot m_e$$

The mass of fundamental entities *k & o* has now been evaluated, and the entities weigh in terms of the electron volt as follows:

$m_k = 67\ keV$ $\qquad$ $m_o = 50\ keV$

$m_d = 9.3\ MeV$ $\qquad$ $m_u = 2.3\ MeV$

$m_c = 1.27\ GeV$ $\qquad$ $m_s = 105\ MeV$

$m_t = 172.7\ GeV$ $\qquad$ $m_b = 4.8\ GeV$

Considering the large range and asymmetry of the six quark masses – the Fine Structure Constant *Alpha* and *Triads* reproduce the masses faithfully.

3.1 The Quark Triads Combination Table (*gko04*):

A quark triad describes composition of Baryons such as the Proton $p = udu$ and the Neutron $n = dud$. The complete permutation on a quark triad with the basic Up u and Down d quarks gives a total of $4^3 = 64$ quark triads. After removing some 44 duplications, 20 distinct quark triads remain, whereof only 8 are previously known in the Standard Model *[Ref. 1]*. At a closer look, 8 new topological entities fit the description of the Strange, Charm, Bottom and Top quarks. The 20 unique quark triads have the greatest information content when arranged into a table with four columns and five rows - which we name "The Quark Triad Combination Table" or **QTC** for brevity:

uuu	Δ^{++}	udu	Δ^{+}	dud	Δ^{0}	ddd	Δ^{-}
$u\bar{u}u$	t	$ud\bar{u}$	s	$du\bar{d}$	c	$d\bar{d}d$	b
$u\bar{d}u$	u''	$\bar{u}d\bar{u}$	$\bar{u}''$	$\bar{d}u\bar{d}$	$\bar{d}''$	$d\bar{u}d$	d''
$\bar{u}u\bar{u}$	$\bar{t}$	$\bar{u}\bar{d}u$	$\bar{s}$	$\bar{d}\bar{u}d$	$\bar{c}$	$\bar{d}d\bar{d}$	$\bar{b}$
$\bar{u}\bar{u}\bar{u}$	$\bar{\Delta}^{--}$	$\bar{u}\bar{d}\bar{u}$	$\bar{\Delta}^{-}$	$\bar{d}\bar{u}\bar{d}$	$\bar{\Delta}^{0}$	$\bar{d}\bar{d}\bar{d}$	$\bar{\Delta}^{+}$

TABLE IV

The top and bottom row contain the eight *Delta* baryons *Δ*. The second and fourth row reveals new presentation of the *Top t*, *Strange s*, *Charm c* and *Bottom b* quarks. In the middle row, new entities appear which we prefer to name double primed quarks, *d´´* and *u´´,* with an electric charge of *-4/3* and *5/3* respectively. It should be noted that the four Delta Baryons in the "corner" have <u>one</u> unique presentation each, the four Strange *s* and Charm *c* quarks have <u>six</u> presentations each, while the remaining twelve entities have <u>three</u> cyclic presentations such as $\Delta^+ = udu = uud = duu$ and $\Delta^0 = dud = ddu = udd$. This gives permutations sequences *{1, 3, 6}* and *{4, 4, 12}*.

3.2 Tetrahedron of Quark Triads with Strange and Charmed quarks:

The total numbers of permutations on a quark triad with three generations can be calculated as 12^3 or 1728 quark triads. With two generations or 144 quark triads, a Gell-Mann tetrahedron with four levels accounts for further 40 quark-triads, including the Delta Baryons from Table ***4***:

$$ccc = \Omega_{ccc}{}^{++}$$

$$ccs = \Omega_{cc}{}^{+}$$
$$ccd = \Xi_{cc}{}^{+} \qquad ccu = \Xi_{cc}{}^{++}$$

$$css = \Omega_{c}{}^{0}$$
$$cds = \Xi_{c}{}^{0} \qquad cus = \Xi_{c}{}^{+}$$
$$cdd = \Sigma_{c}{}^{0} \qquad cud = \Sigma_{c}{}^{+} \qquad cuu = \Sigma_{c}{}^{++}$$

$$sss = \Omega^{-}$$
$$dss = \Xi^{-} \qquad uss = \Xi^{0}$$
$$dds = \Sigma^{-} \qquad uds = \Sigma^{0} \qquad uus = \Sigma^{+}$$
$$ddd = \Delta^{-} \qquad udd = \Delta^{0} \qquad uud = \Delta^{+} \qquad uuu = \Delta^{++}$$

TABLE V

3.3 Triads of Fundamental Entities (*gko04*):

The 20 combination of triads in Table ***4*** is now applied to <u>*new*</u> fundamental entities *o* & *k* where *o* is uncharged and right-handed, but *k* is charged and positive of magnitude $Q = e/3$. The total charge Q of any such fundamental triad fulfils $Q/e = \{0, \pm 1/3, \pm 2/3, \pm 1\}$ which reproduces the charges on Neutrinos, Down quarks, Up quarks and Electrons respectively. We name this table "The Fundamental Triad Combinations" (**FTC**):

kkk	$\bar{e}$	kok	u	oko	$\bar{d}$	ooo	ν_e
$k\bar{k}k$	k_3	$ko\bar{k}$	o_2	$ok\bar{o}$	k_2	$o\bar{o}o$	o_3
$k\bar{o}k$	u'	$\bar{k}o\bar{k}$	$\bar{u}'$	$\bar{o}k\bar{o}$	$\bar{d}'$	$o\bar{k}o$	d'
$\bar{k}k\bar{k}$	$\bar{k}_3$	$\bar{k}\bar{o}k$	$\bar{o}_2$	$\bar{o}\bar{k}o$	$\bar{k}_2$	$\bar{o}o\bar{o}$	$\bar{o}_3$
$\bar{k}\bar{k}\bar{k}$	e	$\bar{k}\bar{o}\bar{k}$	$\bar{u}$	$\bar{o}\bar{k}\bar{o}$	d	$\bar{o}\bar{o}\bar{o}$	$\bar{\nu}_e$

TABLE VI

The top and bottom row defines the Electrons *e*, Up quarks *u*, Down quarks *d* and Neutrinos ν_e of the 1st generation. The second and the fourth row define the 2nd and 3rd generation of the basic fundamental entities *o* & *k*, and the middle row reveals two new "primed" quarks *u´* and *d´* which will reveal their purpose in Section ***3.5***.

3.4 Three Generations of Entities:

In the same manner that an Up/Down quark triad breeds exited quarks, the fundamental triad breeds exited fundamental entities, both $\{o_2, k_2\}$ and $\{o_3, k_3\}$ as shown here below:

k_1	=	k	o_1	=	o
k_2	=	$ok\bar{o}$	o_2	=	$ko\bar{k}$
k_3	=	$kk\bar{k}$	o_3	=	$oo\bar{o}$
$\bar{k}_3$	=	$\bar{k}\bar{k}k$	$\bar{o}_3$	=	$\bar{o}\bar{o}o$
$\bar{k}_2$	=	$\bar{o}\bar{k}o$	$\bar{o}_2$	=	$\bar{k}\bar{o}k$
$\bar{k}_1$	=	$\bar{k}$	$\bar{o}_1$	=	$\bar{o}$

TABLE VII

The fundamental character of *k* or *o* is preserved in all three generations. Table ***7*** in fact gives a logical explanation for the appearance of three and only three basic generations of the subatomic entities. The complete arsenal of electrons, quarks and neutrinos can now be expressed in a simple manner with *i* as a generation index:

i	$k_ik_ik_i$	$k_io_ik_i$	$o_ik_io_i$	$o_io_io_i$
1	$\bar{e}$	u	$\bar{d}$	ν_e
2	μ^+	c	$\bar{s}$	ν_μ
3	τ^+	t	$\bar{b}$	ν_τ

TABLE VIII

Conjugation gives 6 Electrons, 6+6 Quarks and 6 Neutrinos, a total of 24 entities behaving as the spin ½ Leptons/Quarks of the Standard Model *[Ref. 1]*.

3.5 Quarks, Primed Quarks and the double primed Quarks:

In Section ***3.1*** and Section ***3.3***, funny quark entries were revealed and labeled d', u', d'', u'' with an electric charge of magnitude $Q/e = \{1/3, 2/3, 4/3, 5/3\}$ respectively. We will see that these entities are either dual to the Up- and Down- quarks, or transient configurations. The four irregular quark entities can be paired up and written as a transmutation process:

$$\begin{array}{l|l} d' + \bar{d}' \to d + \bar{d} & d'' + \bar{d}'' \to n + \bar{n} \\ u' + \bar{d}' \to \bar{e} + \bar{\nu}_e & u'' + \bar{d}'' \to \Delta^{++} + \Delta^{+} \\ u' + d' \to k_3 + o_3 & u'' + d'' \to t + b \\ u' + \bar{u}' \to u + \bar{u} & u'' + \bar{u}'' \to p + \bar{p} \end{array}$$

TABLE IX

On the left from top down, primed Quark pairs transform to Quark pairs, an Electron and a Neutrino or a 3rd generation fundamental entity. On the right, double primed Quark pairs transform to a pair of Baryons or into the 3rd generation quarks Bottom and Top.

3.6 Proton Stability from Quark Triads:

Let the plus + sign separate free entities, while adjacency or parenthesis indicates bound entities. To test the decay predictions of the fundamental triad hypothesis, let us write down the proton transmutation process and investigate its stability and/or decay mechanism:

$$p \equiv\ udu = \left(kok + \bar{o}\bar{k}\bar{o} + kok\right) \leftarrow \left(kkk + k\bar{o}\bar{k} + \bar{o}oo\right) = \bar{e} + \bar{o}_2 + o_3$$

The occurrence of the 2nd and 3rd generation fundamental neutral entities o_2 and o_3 guaranties that this process progresses only to the left as indicated by (←). To investigate the Proton, independent of notation, the primed quarks in Table ***4*** come in handy as seen by the following expressions for both the Proton and Neutron:

$$p = udu = \begin{bmatrix} k & \bar{o} & k \\ o & \bar{k} & o \\ k & \bar{o} & k \end{bmatrix} = \begin{bmatrix} u' \\ d' \\ u' \end{bmatrix} \qquad\qquad n = dud = \begin{bmatrix} \bar{o} & k & \bar{o} \\ \bar{k} & o & \bar{k} \\ \bar{o} & k & \bar{o} \end{bmatrix} = \begin{bmatrix} \bar{d}' \\ \bar{u}' \\ \bar{d}' \end{bmatrix}$$

The primed quarks d' & u' appear as rows while the d & u quarks appear as columns in the matrix representing the nucleons p & n. With the matrix notation, the internal dynamics is more apparent and one can see that the Proton has a residue kkk while the Neutron has a residue $\bar{o}\bar{o}\bar{o}$ and must therefore be left handed. An interesting property of the Proton is her identical presentation from normal Quarks $\{d, u\}$ and primed quarks $\{d', u'\}$, contrary to the Neutron as seen in the expressions above.

The stability of the proton has been secured – as in isolation – *she* can only transform into extremely transient fundamental entities that can only exist inside the higher generation neutrinos and quarks.

3.7 Transmutations, synthesis and decay:

Let's consider the Muon μ^- decaying into an Electron e, implicitly negative, and two modes* of Neutrinos:

$$\mu^- \equiv \bar{k}_2\bar{k}_2\bar{k}_2 = \left(o\bar{k}\bar{o} + o\bar{k}\bar{o} + o\bar{k}\bar{o}\right) \to \left(ko\bar{k} + ko\bar{k} + ko\bar{k}\right) + \bar{k}\bar{k}\bar{k} + \bar{o}\bar{o}\bar{o} = \nu_\mu + e + \bar{\nu}_e$$

The Muon neutrino is necessary to preserve the topology of the Muon itself when it unfolds and ejects an Electron e and a Neutrino. The Tauon decay gives similar results:

$$\begin{aligned}&\tau^- \equiv \bar{k}_3\bar{k}_3\bar{k}_3 = \left(k\bar{k}\bar{k} + k\bar{k}\bar{k} + k\bar{k}\bar{k}\right) \to \\ &\left(oo\bar{o} + oo\bar{o} + oo\bar{o}\right) + \left(o\bar{k}\bar{o} + o\bar{k}\bar{o} + o\bar{k}\bar{o}\right) + \left(\bar{k}\bar{o}k + \bar{k}\bar{o}k + \bar{k}\bar{o}k\right) = \nu_\tau + \mu^- + \bar{\nu}_\mu\end{aligned}$$

Muons and Tauons both produce two neutrinos, a right-handed same- generation, and a left-handed next generation below and for a lepton l_i with $i = 2, 3$ as an index we get:

$$l_i \equiv \bar{k}_i\bar{k}_i\bar{k}_i \to o_io_io_i + \bar{k}_{(i-1)}\bar{k}_{(i-1)}\bar{k}_{(i-1)} + \bar{o}_{(i-1)}\bar{o}_{(i-1)}\bar{o}_{(i-1)} = \nu_i + l_{(i-1)} + \bar{\nu}_{(i-1)}$$

This metamorphosis is of the general form $k_{i+1} \to \bar{o}_{i+1} + k_i + o_i$ which we can apply to explore the quark transmutations that among other things explains the Neutron n decay:

$$\begin{aligned}d &\equiv \bar{o}\bar{k}\bar{o} \to kok + \bar{k}\bar{k}\bar{k} + \bar{o}\bar{o}\bar{o} = u + e + \bar{\nu}_e \\ u &\equiv kok \leftarrow \bar{o}\bar{k}\bar{o} + kkk + ooo = d + \bar{e} + \nu_e\end{aligned}$$

$$\begin{aligned}s &\equiv \bar{o}_2\bar{k}_2\bar{o}_2 \leftarrow k_2o_2k_2 + \bar{k}_2\bar{k}_2\bar{k}_2 + \bar{o}_2\bar{o}_2\bar{o}_2 = c + \mu + \bar{\nu}_\mu \\ c &\equiv k_2o_2k_2 \to \bar{o}_2\bar{k}_2\bar{o}_2 + k_2k_2k_2 + o_2o_2o_2 = s + \bar{\mu} + \nu_\mu\end{aligned}$$

To check the consistency of Table ***4*** for the 2nd generation quarks, Strange and Charm, we can rewrite the quarks in terms of their fundamental triads:

$$\begin{aligned}s &\equiv \bar{o}_2\bar{k}_2\bar{o}_2 = \left(k\bar{o}\bar{k} + o\bar{k}\bar{o} + k\bar{o}\bar{k}\right) = \left(kok + \bar{o}\bar{k}\bar{o} + \bar{k}\bar{o}\bar{k}\right) = \left(u + d + \bar{u}\right) = ud\bar{u} \\ c &\equiv k_2o_2k_2 = \left(ok\bar{o} + ko\bar{k} + ok\bar{o}\right) = \left(\bar{o}\bar{k}\bar{o} + kok + oko\right) = \left(d + u + \bar{d}\right) = dud\end{aligned}$$

The equality symbol throughout the statements emphasis the equivalency of the expressions used. To evaluate the 3rd generation quarks Top and Bottom, we start writing the possible decay process:

$$\begin{aligned}b &\equiv dd\bar{d} = \left(\bar{o}\bar{k}\bar{o} + \bar{o}\bar{k}\bar{o} + oko\right) \leftarrow \left(kok + kok + \bar{k}\bar{o}\bar{k}\right) + \left(e + \bar{\nu} + \bar{e}\right) + \left(\nu + e + \bar{\nu}\right) = t + \bar{z}_2 + w_2 \\ t &\equiv uu\bar{u} = \left(kok + kok + \bar{k}\bar{o}\bar{k}\right) \to \left(ok\bar{o} + ko\bar{k} + \bar{o}\bar{k}\bar{o}\right) + \left(e + \nu + \bar{e}\right) + \left(\nu + \bar{e} + \bar{\nu}\right) = b + z_2 + \bar{w}_2\end{aligned}$$

Notice a triad of Electrons and Neutrinos defining bound entities, z_2 and w_2, which give an internal mechanism for the electroweak bosons Z^0 and $W^{\pm}$ *[Ref. 1]*, and strengthens both the 20 Quark Triad Combinations (***QTC***) as well as the 20 Fundamental Triad Combinations (***FTC***).

3.8 Neutrino transmutations:

The decomposition of the Muon neutrinos into fundamental entities will now be examined. For oscillating processes, the bidirectional arrow (↔) will be used as a transmutation symbol:

$$\nu_\mu \equiv o_2 o_2 o_2 = \left(ko\bar{k} + ko\bar{k} + ko\bar{k}\right) \leftrightarrow \left(ok\bar{o} + ok\bar{o} + ok\bar{o}\right) + \bar{k}\bar{k}\bar{k} + ooo = \mu^+ + e^- + \nu_e$$

The Muon neutrino ν_μ contains opposite fundamental charges and therefore should have some mass! Notation independent expression for the 2nd and 3rd generation Neutrinos gives:

$$\nu_\mu = o_2 o_2 o_2 = \begin{bmatrix} k & k & k \\ o & o & o \\ \bar{k} & \bar{k} & \bar{k} \end{bmatrix} = \begin{bmatrix} \bar{e} \\ \nu_e \\ e \end{bmatrix} \qquad \nu_\tau = o_3 o_3 o_3 = \begin{bmatrix} o & o & o \\ o & o & o \\ \bar{o} & \bar{o} & \bar{o} \end{bmatrix} = \begin{bmatrix} \nu_e \\ \nu_e \\ \bar{\nu}_e \end{bmatrix}$$

$$\mu^+ = k_2 k_2 k_2 = \begin{bmatrix} o & o & o \\ k & k & k \\ \bar{o} & \bar{o} & \bar{o} \end{bmatrix} = \begin{bmatrix} \nu_e \\ \bar{e} \\ \bar{\nu}_e \end{bmatrix} \qquad \tau^+ = k_3 k_3 k_3 = \begin{bmatrix} k & k & k \\ k & k & k \\ \bar{k} & \bar{k} & \bar{k} \end{bmatrix} = \begin{bmatrix} \bar{e} \\ \bar{e} \\ e \end{bmatrix}$$

A triad with Electrons and Neutrinos breed exited entities and provide additional explanation for the different generations of Electrons $\{e_1, e_2, e_3\}$ with respective Neutrinos:

$$\begin{array}{ll|ll} e_1 \equiv & e & \nu_1 \equiv & \nu \\ e_2 \equiv & \nu e \bar{\nu} & \nu_2 \equiv & e \nu \bar{e} \\ e_3 \equiv & e e \bar{e} & \nu_3 \equiv & \nu \nu \bar{\nu} \end{array}$$

TABLE X

The Top quark investigated in Section ***3.3*** was seen to breed a new "triad-permutation" with Electrons and Neutrinos configured as $w_2 = \nu e \bar{\nu}$ and $z_2 = e \nu \bar{e}$ and hinting at an internal mechanism for the electroweak bosons $\{Z^o, W^+, W^-\}$ and providing a topological picture.

3.9 Color, Flavor and Generations:

In Section ***3.1*** we saw that members of the Quark Triad had different number of permutations. The same applies to the Fundamental Triad of Section ***3.3*** where Electrons and Neutrinos have <u>one</u> presentation, k_2 and o_2 have <u>six</u> presentations while k_3, o_3, u and d have <u>three</u> presentations each. The Standard Model [1], does not account for the six fold-nature of the Strange and Charm Quarks but the three-fold nature of the Up, Down, Top and Bottom Quarks is identical to the present treatment if we assign colors according to the CMY system:

Blue	Green	Cyan	Red	Magenta	Yellow
kko	kok	koo	okk	oko	ook

The six-fold nature of k_2, o_2, c and s will need a descriptive name with six classes – and could use terminology like flavor, family, etc.

4.1 Rational Nucleon Mass and Stability:

The proton $p = udu$ - examined in Sections ***1.6*** - is the most stable particle, with a super astronomical lifetime of 10^{33} years. The neutron $n = dud$ on the other hand "half-lives" for about 850 seconds decaying into the three entities: {Proton – Electron – Neutrino}. For our delight - the mass of the nucleons is surprisingly simple and economical – using just 22 & 15α as basic quantifiers:

$$m_p = \frac{22 \cdot m_e}{15^2 \cdot \alpha^2} \cdot \left(1 - (15\alpha)^6 + 2 \cdot (15\alpha)^8 + \tfrac{5}{3} \cdot (15\alpha)^{10} + \tfrac{10}{3} \cdot (15\alpha)^{12} \cdots\right)$$

$$m_n = \frac{22 \cdot m_e}{15^2 \cdot \alpha^2} \cdot \left(1 + (15\alpha)^3 + \tfrac{5}{11} \cdot (15\alpha)^4 + \tfrac{40}{11} \cdot (15\alpha)^{10} \cdots\right)$$

The magnetic moments are $\mu_p = 2.792847337\ (e\hbar/2m_p)$ and $\mu_n = -1.9130427\ (e\hbar/2m_n)$ for the proton and neutron respectively. Two Up quarks and one Down quark give a positive moment, while two Down quarks and one Up quark gives a negative moment.

4.2 Rational Mass in the Delta Baryons and Strange Lambda and Sigma Baryons:

The Delta Baryons from Section ***3.1*** all have Isospin $I=3/2$ with quark content: $\Delta^{++} = uuu$, $\Delta^{+} = udu$, $\Delta^{0} = dud$ and $\Delta^{-} = ddd$ while the Lambda Baryon has isospin $I=0$ and $J=3/2$ and contains one stranger quark $\Lambda = usd$:

$$m_\Delta = \frac{15 \cdot m_e}{9 \cdot 13 \cdot \alpha^2} \cdot \left(1 - \tfrac{13}{12} \cdot (15\alpha)^3 \cdots\right) \qquad m_\Lambda = \frac{23 \cdot m_e}{11 \cdot 18 \cdot \alpha^2} \cdot \left(1 + \tfrac{22}{3} \cdot (15\alpha)^5 \cdots\right)$$

The Magnetic Moment of Lambda Baryon is $\mu_\Lambda = -0.613\ (e\hbar/2m_\Lambda)$ and its lifetime is $t = 0.2632ns$.

The Sigma Baryons are three $\Sigma = \{usu, usd, dsd\}$ with isospin $I=1$ and $J=1/2$, $3/2$, $5/2$ etc. The $J=3/2$ is labelled Σ^* and $J=5/2$ labelled Σ^{**} etc.. Considering the smallness of α, a remarkable fit is here:

$$m_{\Sigma+} = \frac{15 \cdot m_e}{11^2 \cdot \alpha^2} \cdot \left(1 - \tfrac{5}{4} \cdot (15\alpha)^4 \cdots\right) \qquad m_{\Sigma^*+} = \frac{16 \cdot m_e}{111 \cdot \alpha^2} \cdot \left(1 - 2 \cdot (15\alpha)^4 \cdots\right)$$

$$m_{\Sigma o} = \frac{15 \cdot m_e}{11^2 \cdot \alpha^2} \cdot \left(1 + 2 \cdot (15\alpha)^3 \cdots\right) \qquad m_{\Sigma^* o} = \frac{16 \cdot m_e}{111 \cdot \alpha^2} \cdot \left(1 + \tfrac{11}{5} \cdot (15\alpha)^3 \cdots\right)$$

$$m_{\Sigma-} = \frac{15 \cdot m_e}{11^2 \cdot \alpha^2} \cdot \left(1 + 5 \cdot (15\alpha)^3 \cdots\right) \qquad m_{\Sigma^*-} = \frac{16 \cdot m_e}{111 \cdot \alpha^2} \cdot \left(1 + \tfrac{5}{2} \cdot (15\alpha)^3 \cdots\right)$$

The Sigma Baryons with $J=1/2$ have the following magnetic moments: $\mu_{\Sigma+} = 2.458\ (e\hbar/2m_{\Sigma+})$, $\mu_{\Sigma 0} = 1.61\ (e\hbar/2m_{\Sigma o})$ and $\mu_{\Sigma-} = -1.16\ (e\hbar/2m_{\Sigma-})$ with the their respective lifetimes: $t_{\Sigma+} = 80.18\ ps$, $t_{\Sigma o} = 0.074\ as$ and $t_{\Sigma-} = 150\ ps$.

The factor 111 = 3x37 will also be seen in the Tauon mass derived in Section ***6.2***.

4.3 Baryons with two and three Strange quarks:

The Xsi Baryons have the same Isospin as the Nucleons, or $I=1/2$. The neutral particle has the quark composition $\Xi^0 = sus$ where s is a Strange quark:

$$m_{\Xi o} = \frac{25\cdot m_e}{13\cdot 14\cdot \alpha^2}\cdot\left(1-\tfrac{23}{12}\cdot(15\alpha)^3\cdots\right) \qquad m_{\Xi^*_0} = \frac{16\cdot m_e}{(10\alpha)^2}\cdot\left(1-\tfrac{7}{4}\cdot(15\alpha)^3\cdots\right)$$

$$m_{\Xi-} = \frac{25\cdot m_e}{13\cdot 14\cdot \alpha^2}\cdot\left(1+\tfrac{11}{6}\cdot(15\alpha)^3\cdots\right) \qquad m_{\Xi^*_-} = \frac{16\cdot m_e}{(10\alpha)^2}\cdot\left(1\pm(15\alpha)^4\cdots\right)$$

The Xsi-null has magnetic moment as $\mu_{\Xi o} = -1.250\ (e\hbar/2m_{\Xi o})$ and lifetime of $t = 0.290\ ns$, while the Xsi-minus has $\mu_{\Xi-} = -0.6507\ (e\hbar/2m_{\Xi-})$ and lifetime of $t = 0.1639\ ns$.

The Omega-minus Baryon has Isospin $I=0$ and the quark configuration is $\Omega^- = sss$ with magnetic moment as $\mu_{\Omega-} = -2.02\ (e\hbar/2m_{\Omega-})$ and lifetime as $t = 82.1\ ps$:

$$m_{\Omega_-} = \frac{(11+12)\cdot m_e}{11\cdot 12\cdot\alpha^2}\cdot\left(1+\tfrac{7}{4}\cdot(15\alpha)^4\cdots\right) \qquad m_{\Omega^*_-} = \frac{(11+12)\cdot m_e}{2\cdot 7^2\cdot\alpha^2}\cdot\left(1\pm(15\alpha)^5\cdots\right)$$

The Xsi and Omega masses above can be written in terms of continued fractions as:

$$m_{\Xi} = \frac{m_e}{\alpha^2}\cdot\Phi_0(7,3,1,1,3) \qquad m_{\Omega^-} = \frac{m_e}{\alpha^2}\cdot\Phi_0(5,1,2,1,5)$$

5.1 Mesons and the 36 Quark duos:

Combining a Quark and an Anti-quark from three generations, a total of 6x6, or 36 basic mesons can be written. In Table ***11*** below, the 36 mesons are arranged into a 6 by 6 array:

$$\begin{array}{llllll}
d\bar{d}=\pi^0 & u\bar{d}=\pi^+ & s\bar{d}=\bar{K}^0 & c\bar{d}=D^+ & b\bar{d}=\bar{B}^0 & t\bar{d}=T^+ \\
d\bar{u}=\pi^- & u\bar{u}=\pi^0 & s\bar{u}=K^- & c\bar{u}=D^0 & b\bar{u}=B^- & t\bar{u}=T^0 \\
d\bar{s}=K^0 & u\bar{s}=K^+ & s\bar{s}=\eta_S & c\bar{s}=D_S{}^+ & b\bar{s}=\bar{B}_S{}^0 & t\bar{s}=T_S{}^+ \\
d\bar{c}=D^- & u\bar{c}=\bar{D}^0 & s\bar{c}=D_S{}^- & c\bar{c}=\eta_C & b\bar{c}=B_C{}^- & t\bar{c}=\bar{T}_C{}^0 \\
d\bar{b}=B^0 & u\bar{b}=B^+ & s\bar{b}=B_S{}^0 & c\bar{b}=B_C{}^+ & b\bar{b}=\gamma_B & t\bar{b}=T_B{}^+ \\
d\bar{t}=T^- & u\bar{t}=\bar{T}^0 & s\bar{t}=T_S{}^- & c\bar{t}=T_C{}^0 & b\bar{t}=T_B{}^- & t\bar{t}=\gamma_T
\end{array}$$

TABLE XI

5.2 Pions - the basic light Mesons:

The charged Pions have a mass of *139.57 MeV* with a mean life of *26.03 ns* while the uncharged Pion π^0 has a mass of *134.976 MeV* and an extremely short mean life of *84 as* and both give the following rational and continued fraction expansion:

$$m_{\pi^\pm} = \frac{4\cdot m_e}{11\cdot(5\alpha)^2} = \frac{m_e}{(5\alpha)^2}\cdot\Phi_0(2,1,3) \qquad m_{\pi^0} = \frac{32\cdot m_e}{7\cdot 13\cdot(5\alpha)^2} = \frac{m_e}{(5\alpha)^2}\cdot\Phi_0(2,1,5,2,2)$$

5.3 Other light Mesons:

The Eta meson came to the attention of this author in connection with Proton synthesis and decay. The numerical factors support this connection to the Proton. In fact, the Eta mass can be expressed as $m_\eta = 7m_p/12$.

$$m_\eta = \frac{77 \cdot m_e}{6 \cdot 15^2 \cdot \alpha^2} \cdot \left(1 - \tfrac{1}{3} \cdot (15\alpha)^4 \cdots\right) = \tfrac{1}{6} \cdot \frac{m_e}{\alpha^2} \cdot \Phi_0(2,\ 1,\ 11,\ 1,\ 5)$$

$$m_{\eta'} = \frac{m_e}{10 \cdot \alpha^2} \cdot \left(1 - \tfrac{13}{9} \cdot (15\alpha)^3 \cdots\right) = \frac{m_e}{\alpha^2} \cdot \Phi_0(10)$$

$$m_{\eta''} = \frac{3 \cdot m_e}{20 \cdot \alpha^2} \cdot \left(1 - \tfrac{1}{3} \cdot (15\alpha)^3 \cdots\right)$$

Other mesons such as the b, ρ, a and $\eta_{(1295)}$ give the following result:

$$m_\rho = 11 \cdot m_e \cdot \alpha^{-1} \qquad m_{\rho_{1450}} = 21 \cdot m_e \cdot \alpha^{-1}$$

$$m_{\eta(1295)} = (15/111) \cdot m_e \cdot \alpha^{-2} = m_e \cdot \alpha^{-2} \cdot \Phi_0(7,2,2)$$

Notice the factor 37 above - also seen in the Tauon and Sigma factoring 111 = 3*37.

5.4 Kaons and other strange Mesons:

The charged Kaons such as $K^- = s\bar{u}$ have the mass *493.677 MeV* with a mean life of *12.38 ns* but the neutral Kaons have the mass *497.67 MeV* and mean life of *89.3 ps* so both weigh around 970 electron masses. When expanded into rational numbers an interesting reciprocal propperty is revealed.

$$m_{K+} = \frac{9 \cdot m_e}{7 \cdot 25 \cdot \alpha^2} = \frac{m_e}{\alpha^2} \cdot \Phi_0(19,2,4) \qquad m_{Ko} = \frac{7 \cdot m_e}{9 \cdot 15 \cdot \alpha^2} = \frac{m_e}{\alpha^2} \cdot \Phi_0(19,3,2)$$

The charged Dee meson has the mass *1869.3 MeV* with a mean life of *1.05 ps* and the uncharged Dee meson has the mass *1864.5 MeV* with a mean life of *0.41 ps* has the largest prime factor.

$$m_D = \frac{27 \cdot m_e}{139 \cdot \alpha^2} = \frac{m_e}{\alpha^2} \cdot \Phi_0(5,6,1,3)$$

The so-called Strange D's are in fact 2nd mode Pions –and using compact CF notation, we have:

$$m_{Ds+} = (m_e/\alpha^2) \cdot \Phi_0(4,1,7) \qquad m_{Ds*+} = (m_e/\alpha^2) \cdot \Phi_0(4,1,1,5)$$

The strange Dee mesons have *1968.5 MeV, 0.49as* and *2112.4 MeV* respectively.

6.1 Mass distribution of Leptons, Mesons and Baryons:

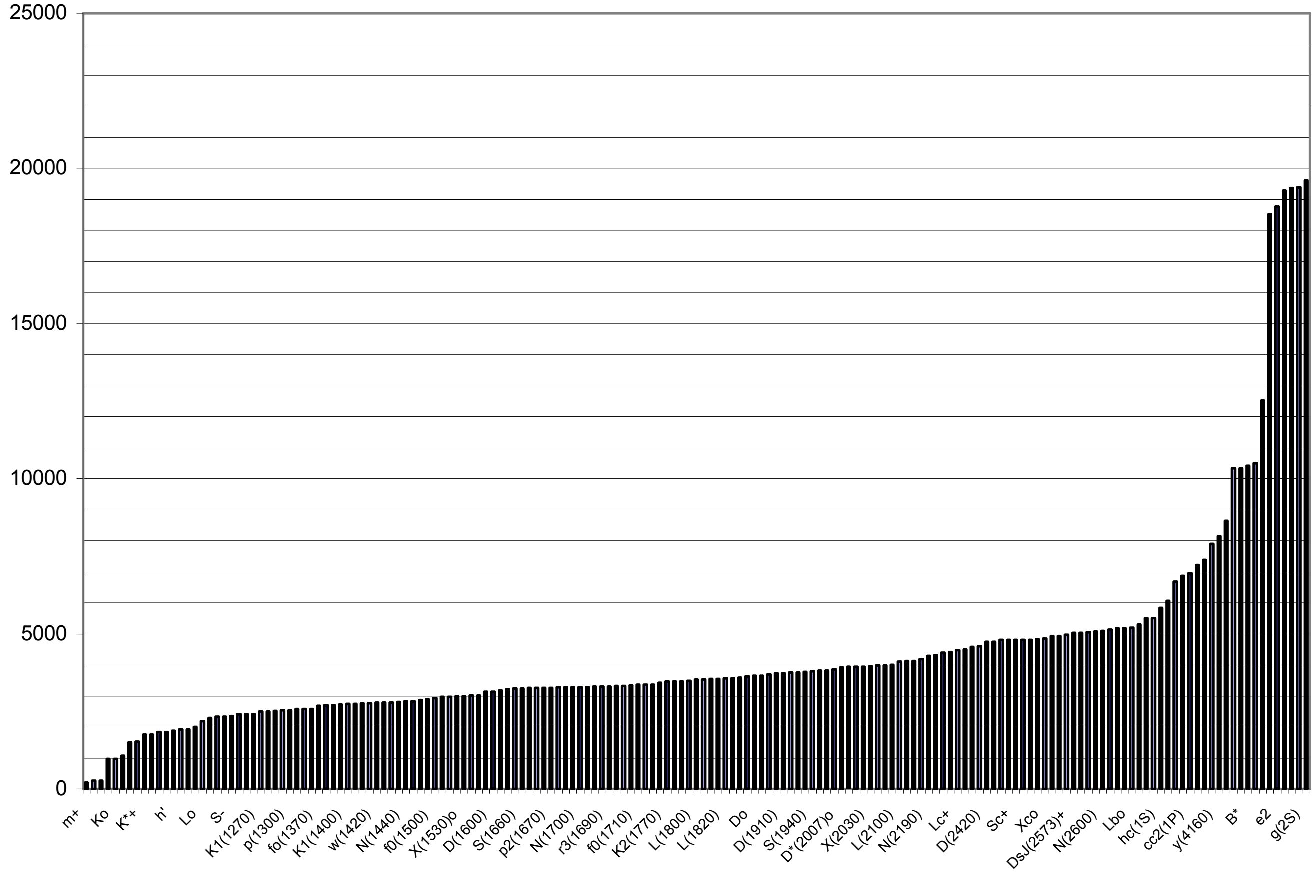


FIGURE IV

7.1 The Gauge Bosons; $W^{+/-}$ & Z^0:

The electro-weak bosons W, Z were discovered to have rationalized masses in terms of the Fine Structure Constant α, and the familiar denominators 11 & 15.

$$m_W = \left(\frac{3 \cdot m_e}{\alpha^3}\right) \cdot \left(\frac{11+11+15}{11 \cdot 11 \cdot 15}\right) \pm \cdots \qquad m_{Zo} = \left(\frac{3 \cdot m_e}{\alpha^3}\right) \cdot \left(\frac{11+11+15}{11 \cdot 11 \cdot 15}\right) + \frac{101 \cdot m_e}{6 \cdot 15 \cdot \alpha^2} \pm \cdots$$

This denominator was first discovered in the Muon mass by this author, but rejected on statistical grounds. In light of the above expressions, I can't resist reporting my Muon mass with precision of 1ppm, which is derived in details in Section ***8. 2***:

$$m_\mu = \left(\frac{7}{6!}\right) \cdot \frac{m_e}{11 \cdot 11 \cdot \alpha^3} \pm \cdots = \left(\frac{7}{6!}\right) \cdot \frac{5 \cdot m_{W\pm}}{37} \pm \cdots$$

Currently, the best estimate of the Z-boson mass is 91186.7 MeV at 20ppm. The reader should now have noticed the repeated occurrences of more or less the same numerical factors in all our mass evaluation –dominating the 11, 15, 37 integers which continually repeat in very different entities!

8.1 Analytical Mass Factors:

If we collect the mass factors encountered in Quarks, Electrons, Nucleons, Mesons and Weak Bosons, the following masses give a good sample of the rational set expressed from the "Fine Structure Constant" α – see Section ***2.1*** – and the integer $a = 4$:

$$m_\mu = \frac{(a+3)}{2\cdot 3\cdot a\cdot (a+1)\cdot (a+2)\cdot (2a+3)}\cdot\left(m_e/\alpha^3\right) \qquad m_\tau = \frac{1}{a\cdot (a+1)\cdot (7a+9)}\cdot\left(m_e/\alpha^3\right)$$

$$m_{\pi^{+/-}} = \frac{a}{(a+1)^2\cdot (2a+3)}\cdot\left(m_e/\alpha^2\right) \qquad m_{K^0} = \frac{(a+3)}{(a+1)\cdot (a-1)^3}\cdot\left(m_e/\alpha^2\right)$$

$$m_N = \frac{2\cdot (2a+3)}{9\cdot (a+1)^2}\cdot\left(m_e/\alpha^2\right) \qquad m_{\Sigma^{+/-}} = \frac{3\cdot (a+1)}{(2a+3)^2}\cdot\left(m_e/\alpha^2\right)$$

$$m_{W^{+/-}} = \frac{(7a+9)}{(a+1)\cdot (2a+3)^2}\cdot\left(m_e/\alpha^3\right)$$

All the mass entries above contain the factors a, $(a+1)$ – explicitly or implicitly. The factors $(a+2)$ and $(a+3)$ are frequent – and five entries contain the factor $(2a+3)$, while two have an odd looking factor $(7a+9)$ – and finally $(a-1)$ factors the Kaon mass. Beside factorial looking entries like $a(a+1)(a+2)$, two "stones" manifest with values $(2a+3)=11$ and $(7a+9)=37$.

8.2 Analytical mass formulae for the Leptons:

When attempting to reconstruct possible cancelled factors in the mass of the Leptons, two analytical expressions came forth:

$$m_\mu = \left(\frac{7}{6!\cdot 11^2}\right)\cdot m_e\cdot\alpha^{-3} \qquad m_\tau = \left(\frac{6}{5!\cdot 37}\right)\cdot m_e\cdot\alpha^{-3}$$

A test can be made if this gives consistent values when extended down – for example by the natural choice $d=11^3$ as the denominator – when the sequence would be 11^3, 11^2, 37.

$$m_x = \left(\frac{8}{7!\cdot 11^3}\right)\cdot m_e\cdot\alpha^{-3} = 3\cdot m_e\cdot\left(1+\alpha\cdot\pi+\tfrac{1}{11}\cdot\alpha^2\cdot\pi^2+\cdots\right)$$

To appreciate the size of m_x it is about 2% heavier than three Electrons or about the same as the minimal estimate for Up-Quark in the Standard Model *[Ref. 1]*, or $m_u > 3\ m_e$.

The repeated occurrences of 11, 15 & 37 as numerical factors – in miscellaneous particle masses, is implying, and next to proving, the existence of very dynamic and harmonic substructure.

9.1 Magnetic Moment of Baryons:

In Section ***2.2*** – the Magnetic Moments of the Leptons was seen to be very regular with $g = 2+\alpha/\pi$ as the main contribution, where g is the (Landau) g-factor. However for the Baryons, the Magnetic Moments take on various values. This fact hinted at both structure and dynamics that the Baryons should possess. From quantum mechanics we soon find that $\boldsymbol{L}^2$ and $\boldsymbol{S}^2$ are the conserved quantities rather than $\boldsymbol{L}$ and $\boldsymbol{S}$ – so we first square the moments before attempting rationalisation. To make a long story short – the following results were obtained for the Nucleons and Sigma:

$$\mu_p = \left(\frac{e\cdot\hbar}{2\cdot m_p}\right)\cdot\left(8-\frac{1}{5}\right)^{\frac{1}{2}}$$

$$\mu_n = \left(\frac{e\cdot\hbar}{2\cdot m_n}\right)\cdot\left(4-\frac{7^2}{12^2}\right)^{\frac{1}{2}}$$

$$\mu_{\Sigma+} = \left(\frac{e\cdot\hbar}{2\cdot m_{\Sigma+}}\right)\cdot\left(6+\frac{1}{24}\right)^{\frac{1}{2}}$$

$$\mu_{\Sigma0} = \left(\frac{e\cdot\hbar}{2\cdot m_{\Sigma0}}\right)\cdot\left(3-\frac{9}{22}\right)^{\frac{1}{2}}$$

$$\mu_{\Sigma-} = \left(\frac{e\cdot\hbar}{2\cdot m_{\Sigma-}}\right)\cdot\left(1+\frac{9}{26}\right)^{\frac{1}{2}}$$

The Magnetic Moment of the transient Baryons is difficult to measure – and only few moments can be tested for rationality at this time. However the 1ppm fit for the Magnetic Moment of the Proton – which is the most accurately measured – gives a strong motivation to persuade this approach. In fact the Magnetic Moments for the *Lambda*-, *Xsi*- and *Omega*- Baryons give rationalised moments with the same factors as above (normalized):

Lambda:	$\mu_{\Lambda} = \sqrt{(1 - 15/24)}$
Xsi-minus:	$\mu_{\Xi^-} = \sqrt{(1 - 15/26)}$
Xsi-zero:	$\mu_{\Xi^0} = \sqrt{(1 + 27/48)}$
Omega-minus:	$\mu_{\Omega^-} = \sqrt{(4 - 2/24)}$

We have now revealed rational mass spectrum and magnetic moments in the subatomic particles – comparable to the discovery of discrete colour spectrum in atoms by Balmer, Rydberg and Bohr during the years 1885-1913 which preceded the theoretical development of Quantum Physics. Our next task is to gain deeper insight into the topology and dynamics of the particle internals based on the 20 ***QTC*** and ***FTC*** laid down in Section ***3.1*** and ***3.3***.

A good fit for the Neutron Magnetic Moment has been known for decades and is $\mu_n = 44/23$ – but has not been revealed as such in the present treatment.

10.1 Summary and discussion:

♦ We retraced the steps back to ancient history in Section ***1.1*** – to gain insight into the harmonic and dynamic reality, which seems to reveal itself in the Subatomic Entities.

♦ Continued Fractions are used as a window into the algebraic content of the Subatomic Entities – and with a considerable success. The most striking example is the Nucleon mass: $m_N = 22/15^2$ – scaled with α^2, which is the *Alpha* constant discussed in Sections ***2.1 – 2.3***.

♦ The *Plank Mass* and its connection with *Alpha* and *Electrons* is a direct motivation to expect and pursue rational masses and moments based on the "Rational Newton-Coulomb Ratio".

♦ We show that the Strange, Bottom, Charm and Top quarks can all be described as an Up/Down quark triad of a special configuration. We also show, that Electrons, Quarks and Neutrinos can be described as a still more fundamental triad – made from two fundamental entities: a neutral right *o* and a charged positive *k* with electric charge $Q = e/3$.

♦ Before an "Entity" and an "Anti-entity" breaks apart inside a decaying particle it is engaged in an extreme spin around a third entity. The author argues that such a dynamical picture emerges from an expression like $s = ud\bar{u}$ which shows an Up quark u and an Anti-up quark $\bar{u}$ bound to a Down quark d giving it the appearance of a Strange quark s of the 2nd generation.

♦ Using the fundamental triad with simple conservation rules and color assignments, we successfully predict stability or decay mechanism down to the last detailed neutrino.

♦ The Muon neutrino appears to be massive compared to the Electron neutrino and to the Tauon neutrino. A massive neutrino can undergo transmutations and generation oscillations.

♦ A new observation made January 2005 explains the "mass-asymmetry" in Quarks - where the Up quark is "light" but Charm and Top "heavy" is demonstrated in Section ***2.3***.

♦ By counting the degeneracy or variety in the organisation among the fundamental entities o & k in different classes of particles, such as fat electrons, quarks, mesons and baryons, we get head on fit with each entities mass, even down to 1ppm, which is one part in a million.

♦ Mass bookkeeping and precision must adhere to the fact, *[Ref. 4]* – that we should not expect the same fundamental constants to apply near a huge mass or in gravitationally empty space.

♦ We make progress in calculation of Magnetic Moments of many Baryons - and rational structures seem to be revealed – but now "squared" because of conservation consideration.

References:

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[4] G.K.OTTARSSON (Pro%Nil Systems), Physics of Action (1999 Sept. 9) (URL: http://www.islandia.is/gko)