Hexark and Preon Model #6: the building blocks of elementary particles. Electric charge is determined by hexatone and gives a common link between QED and QCD.

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Abstract

The paper shows a model for building elementary particles, including the higgs, dark matter and neutral vacuum particles, from preons and sub-preons. The preons are built from string-like hexarks each with chiral values for the fundamental properties of elementary particles. Elementary particles are unravelled and then reformed when preons disaggregate and reaggregate at particle interactions. Hexark colours are separately described by hue (hexacolour) and tone (hexatone). Hexacolour completely determines particle colour charge and hexatone completely determines particle electric charge. Hexacolour branes within the electron intertwine to form a continuously rotating triple helix structure. A higgs-like particle is implicated in fermions radiating bosons.

Hexarks

It is assumed here that the smallest parts for particle building are hexarks. Quarks make the fourth order layer, preons the fifth order and hexarks the sixth order. Particles have the following fundamental properties: chirality (left- or right-handedness), electric charge, spin, weak isospin, colour charge, matter/antimatter and mass. The hexarks need to be constructed with respect to these properties.

These eight properties in terms of hexarks are chirality (L or R handedness) in spacetime, matter or antimatter (antimatter denoted by '), electric charges (+ or -), spin (+ or -) and weak isospin (+ or -), three hexacolour/antihexacolour charges (red, green, blue, antired, antigreen and antiblue). Mass is assumed here to be an emergent property and not fundamental. The metric of space and time is also deemed to be an emergent property which also is not necessary to be modelled in particle structures.

In this model, it is not necessary to include electric charge for hexarks as there is a correspondence between a particle's electric charge and its net hexark/preon hexacolour. If the three hexacolours are each designated as having white hexatone and the antihexacolours as having black hexatone, then negative electric charge corresponds to a predominance of white hexatone and positive electrical charge corresponds to a predominance of black hexatone. This correspondence does not apply for elementary particle colours as the red up and red down quarks have electric charges with opposite signs. The hexacolour charges for up and down quarks are predominantly black and white in hexatone, respectively, corresponding exactly to their electric charges. Despite the replacement of electric charge by hexatone in the fundamental properties, electric charge is much too familiar a term to be left out of the description of the hexark structures. The use of 'tone' is borrowed from art colour theory and the amount of electric charge of a particle depends exactly on its hexatone.

The negative electric charge is, furthermore, connected only to left-handed hexarks, L, and anti-right-handed antihexarks, R'. Right-handed hexarks, R, and anti-left-handed antihexarks, L', will have only positive electric charges. Hexacolour charges are therefore embodied in the L and R' hexarks while antihexacolour charges are embodied in the R and L' hexarks. Every hexark has spin of either + or - and has weak isospin of either + or -.

The total number of hexarks in the model is 48. There are 24 matter hexarks (L and R) and a corresponding 24 antimatter antihexarks (denoted L' and R'). Hexarks can be labelled as: (Hexark handedness and matter/antimatter) (electric charge) (spin) (weak isospin) (hexacolour charge) for example, R' - + - r, and are shown in Tables 1a and 1b.

Table 1a: Chiral structures of the 24 hexarks

L - - - r	L - - + r	L - + - r	L - + + r
L - - - g	L - - + g	L - + - g	L - + + g
L - - - b	L - - + b	L - + - b	L - + + b
R + - - r'	R + - + r'	R + + - r'	R + + + r'
R + - - g'	R + - + g'	R + + - g'	R + + + g'
R + - - b'	R + - + b'	R + + - b'	R + + + b'

Table 1b: Chiral structures of the 24 antihexarks

L' + + + r'	L' + + - r'	L' + - + r'	L' + - - r'
L' + + + g'	L' + + - g'	L' + - + g'	L' + - - g'
L' + + + b'	L' + + - b'	L' + - + b'	L' + - - b'
R' - + + r	R' - + - r	R' - - + r	R' - - - r
R' - + + g	R' - + - g	R' - - + g	R' - - - g
R' - + + b	R' - + - b	R' - - + b	R' - - - b

A hexark's electric charge is + or - 1/48; A hexark's spin is + or - 1/48; A hexark's weak isospin is + or - 1/48. A hexark's hexatone is also + or - 1/48.

Preons and sub-preons

Preons and sub-preons, in Model #6, are made of aggregates of hexarks. Unlike in the Rishon preon model (Harari, 1979, and Shupe, 1979) which does not use hexarks, in Model #6 there are four preons: A, B, C and D, which have antimatter versions: A', B', C' and D'. Preon C has no spin or weak isospin and is divisible into three colour sub-preons: Cr, Cg and Cb with "antimatter" versions C'r', C'g' and C'b'. The hexark content of each preon and sub-preon is given in the Appendix. Each preon contains twelve hexarks and twelve antihexarks. Properties of the preons and sub-preons are shown in Table 2.

Table 2: The four preons and three hexacoloured sub-preons

Preon	Number of hexarks	Electric charge	Spin	Weak isospin	Hexatone
A	24	-1/2	-1/2	-1/2	White (-0.5)
B	24	-1/2	+1/2	0	White (-0.5)
C	24	-1/2	0	0	White (-0.5)
D	24	-1/2	0	+1/2	White (-0.5)
A'	24	+1/2	+1/2	+1/2	Black (0.5)
B'	24	+1/2	-1/2	0	Black (0.5)
C'	24	+1/2	0	0	Black (0.5)
D'	24	+1/2	0	-1/2	Black (0.5)
Sub-preon					
					Hexacolour (and hexatone)
Cr	8	-1/6	0	0	Red (-1/6)
Cg	8	-1/6	0	0	Green (-1/6)
Cb	8	-1/6	0	0	Blue (-1/6)
C'r'	8	+1/6	0	0	Antired (1/6)
C'g'	8	+1/6	0	0	Antigreen (1/6)
C'b'	8	+1/6	0	0	Antiblue (1/6)

The whiteness or blackness of the preons does not affect elementary particle colours but does affect the elementary particle electric charge. Therefore a, say, hexared preon must have a negative electric charge but a red quark could have a positive or negative electric charge depending on the net whiteness or blackness, that is the net hexatone, of its preons and sub-preons. Every preon is composed of twelve matter hexarks and twelve antihexarks. Every sub-preon is composed of four hexarks and four antihexarks

Elementary particles are comprised, in this model, of various numbers of preons depending on whether a particle is fermion or boson and depending on the particle generation. The higher the generation, the more preons are included. The numbers of preons per elementary particle are listed in Table 4.

Table 4: Numbers of preons per elementary particle

Elementary particles are made from combinations of various numbers of preons:

Four preons	(electron, photon, neutrino)
eight preons	(Z, W)
twelve preons	(muon, muon neutrino)
sixteen preons	(higgs, gluon)
twenty preons	(tau, tau neutrino)
three coloured sub-preons plus three preons	(up and down quarks)
three coloured sub-preons plus eleven preons	(charm and strange quarks)
three coloured sub-preons plus nineteen preons	(top and bottom quarks)

Although the numbers of preons in Table 4 are stated without explanation, they were derived based on likely numbers of preons per particle with respect to particle interactions in which the preons going into an interaction need to balance exactly the preons coming out of the interactions: complicated by the presence of preons coming from the vacuum or being annihilated into the vacuum at an interaction. This requires that vacuum energy be modelled by vacuum particles/fields containing preons. For example, AA'BB' could be a completely neutral vacuum particle/field.

There are three hexacoloured sub-preons and combinations of them can arise. Table 5 shows how to find the quark colour for any combination of the three different sub-preons.

Table 5: How to find a quark colour from the hexacolours of its sub-preons

First sub-preon hexacolour	Second sub-preon hexacolour	Third sub-preon hexacolour	Quark colour
r	g	b’	antiblue
r	g’	b	antigreen
r	g’	b’	red
r’	g	b	antired
r’	g	b’	green
r’	g’	b	blue

Two hexacolours when aggregated form the anticolour of the third hexacolour. For example, r + g makes antiblue; so r + g + b' = (r + g) + b' = (antiblue) + antiblue = antiblue.

Table 6 shows that the up and down quark electric charges are determined by the greyness, or hexatone, of the hexacolours of the preons and sub-preons of which the quarks are composed. For brevity, only the left-handed forms of the quarks are displayed in the table but the right-handed forms also conform to this pattern.

Table 6: Up and down quark electric charge, quark colour and net preon greyness

Preon and sub-preons in quarks	Electric charge	Preon hexatone	Particle Colour	Quark name
B D' C Cg C'r' Cb	-2/3	-1/2 +1/2 -1/2 -1/6 +1/6 -1/6 = -2/3	r'	LH antiup
B D' C C'g' Cr Cb	-2/3	-1/2 +1/2 -1/2 +1/6 -1/6 -1/6 = -2/3	g'	LH antiup
B D' C Cg Cr C'b'	-2/3	-1/2 +1/2 -1/2 -1/6 -1/6 +1/6 = -2/3	b'	LH antiup
A C'g' Cr C'b' x^1	-1/3	-1/2 +1/6 -1/6 +1/6 = -1/3	r	LH down
A Cg C'r' C'b' x^1	-1/3	-1/2 -1/6 +1/6 +1/6 = -1/3	g	LH down
A C'g' C'r' Cb x^1	-1/3	-1/2 +1/6 +1/6 -1/6 = -1/3	b	LH down
B' Cg Cb C'r' x^1	1/3	1/2 -1/6 -1/6 +1/6 = 1/3	r'	LH antidown
B' C'g' Cb Cr x^1	1/3	1/2 +1/6 -1/6 -1/6 = 1/3	g'	LH antidown
B' Cg C'b' Cr x^1	1/3	1/2 -1/6 +1/6 -1/6 = 1/3	b'	LH antidown
B' D C' C'g' Cr C'b'	2/3	1/2 -1/2 +1/2 +1/6 -1/6 +1/6 = 2/3	r	LH up
B' D C' Cg C'r' C'b'	2/3	1/2 -1/2 +1/2 -1/6 +1/6 +1/6 = 2/3	g	LH up
B' D C' C'g' C'r' Cb	2/3	1/2 -1/2 +1/2 +1/6 +1/6 -1/6 = 2/3	b	LH up

x^1 is a completely neutral component made up of either AA', BB' or CC' or DD' preon pairs, and is ignored in the calculations of hexatone or greyness.
A preon has a hexatone of + or - ½ while a sub-preon has a hexatone of + or - 1/6.
LH=left-handed RH = right-handed

Using the LH antiup antired quark from Table 6 as an example. Table 4 lists the up and down quarks as having four preons. The three sub-preons in the quark count as one whole preon in terms of numbers of hexarks contained. The component x^1 is a completely neutral pair of preon and antipreon, for example AA', and does not contribute to net hexatone/ greyness of the quark. Table 5 can be used to find the quark colour r' corresponding to three sub-preon hexacolours g, b and r'. The three sub-preon hexacolours are then written as hexatone values: g + b + r' = -1/6 -1/6 +1/6 = -1/6. The B, D' and C preons are also present in this quark and their hexatones are -0.5, +0.5 and -0.5 respectively, giving an overall total hexatone of -2/3. The quark electric charge corresponds exactly to the preon hexatone for each quark form.

Hexark properties of electric charge (hexatone), spin and weak isospin are additive when calculating those properties of the preons and elementary particles. Every preon and every sub-preon contains as many matter hexarks as anti-matter hexarks.

Elementary particles as combinations of preons and sub-preons

Tables 7 to 14 show combinations of preons and sub-preons forming all the Standard Model particles and also some extra particles.

The four-unit combinations are the smallest combinations which allow for the photon and higgs particles and the four-unit block is taken here as the smallest form of any elementary particle. For example a left-handed electron could be ACAA' or ACBB' or ACCC' or ACDD' where AA', BB', CC' and DD' act as neutral bulk fillers. This means that not every electron is identical and could imply that not every electron is equally likely to be able to participate in an interaction.
Neutral pairs of preon and antipreon are also important to the preon model as they form neutral building blocks which are the only difference between similar particles in different generations, for example electron and muon.

Table 7: Four preons (electron, photon and neutrino)

Preon units	Electric charge	Spin	Weak isospin	Particle name
ACx^1	-1	-0.5	-0.5	LH electron
BCx^1	-1	0.5	0	RH electron
$A'C'x^1$	1	0.5	0.5	RH positron
$B'C'x^1$	1	-0.5	0	LH positron
$B'Dx^1$	0	-0.5	+0.5	LH neutrino
$BC'x^1$	0	0.5	0	RH sterile neutrino
$BD'x^1$	0	0.5	-0.5	RH antineutrino
$B'Cx^1$	0	-0.5	0	LH sterile antineutrino
B'B'CC or ADB'C'	0	-1	0	Photon
BBC'C' or A'D'BC	0	1	0	Photon
non-Standard Model				
x^2	0	0	0	neutral particle
ABC'C' or $D'Cx^1$	0	0	-0.5	Higgs-like particle (1/4 higgs)
A'B'CC or $DC'x^1$	0	0	+0.5	Higgs-like particle (1/4 higgs)

where x^1=any one of four pairs: AA' or BB' or CC' or DD'
and where x^2= any two pairs from AA' or BB' or CC' or DD', for example AA'AA' or AA'DD'

The higher generations of particles use the above basic forms of the first generation with the addition of neutral pairs of preon units. Quark forms are given in Tables 12 to 14.

Table 8: Eight preons (Z and W)

Preons	Electric charge	Spin	Weak isospin	Particle name
AAx^3	-1	-1	-1	W-
$A'A'x^3$	1	1	1	W+
BBx^3	-1	1	0	W-
$B'B'x^3$	1	-1	0	W+
$B'B'CCx^2$ or $ADB'C'x^2$	0	-1	0	Z
$BBC'C'x^2$ or $A'D'BCx^2$	0	1	0	Z
non-Standard Model				
x^4	0	0	0	neutral particle
$ABC'C'x^2$ or $D'Cx^3$	0	0	-0.5	Higgs-like particle (1/2 higgs)
$A'B'CCx^2$ or $DC'x^3$	0	0	0.5	Higgs-like particle (1/2 higgs)

where x^2 = any two pairs of preons from AA' or BB' or CC' or DD', for example AA'AA' or AA'BB' or BB'DD'
where x^3 = any three pairs of preons from AA' or BB' or CC' or DD', for example AA'AA'BB' or AA'BB'CC'
where x^4 = any four pairs of preons from AA' or BB' or CC' or DD', for example AA'DD'BB'CC'

Table 9: Twelve preons (muon and muon neutrino)

Preons	Electric charge	Spin	Weak isospin	Particle name
ACx^5	-1	-0.5	-0.5	LH muon-
BCx^5	-1	0.5	0	RH muon-
$B'Dx^5$	0	-0.5	0.5	LH muon neutrino
$B'Cx^5$	0	-0.5	0	LH muon sterile antineutrino
$BC'x^5$	0	0.5	0	RH muon sterile neutrino
$BD'x^5$	0	0.5	-0.5	RH muon antineutrino
$B'C'x^5$	1	-0.5	0	LH muon+
$A'C'x^5$	1	0.5	0.5	RH muon+
non-Standard Model				
x^6	0	0	0	scalar particle
$ABC'C'\ x^4$ or $D'Cx^5$	0	0	-0.5	Higgs-like particle (3/4 higgs)
$A'B'CC\ x^4$ or $DC'x^5$	0	0	+0.5	Higgs-like particle (3/4 higgs)

where x^n = any n pairs of preons from AA' or BB' or CC' or DD'

Table 10: Sixteen preons (gluon and Higgs)

Preons[1]	Electric charge	Spin	Weak isospin	Particle name
B'B'CC AA'x^4 C'g' Cr C'b' Cg C'r' Cb	0	-1	0	gluon (rr')
BBC'C' BB'x^4 C'g' Cr C'b' Cg C'r' Cb	0	1	0	gluon (rr')
B'B'CC AA'x^4 Cg C'r' C'b' C'g' Cr Cb	0	-1	0	gluon (gg')
BBC'C' BB'x^4 Cg C'r' C'b' C'g' Cr Cb	0	1	0	gluon (gg')
(Note that the gg' is identical to the rr')				
B'B'CC AA'x^4 C'g' C'r' Cb Cg Cr C'b'	0	-1	0	gluon (bb')
BBC'C' BB'x^4 C'g' C'r' Cb Cg Cr C'b'	0	1	0	gluon (bb')
(Note that the bb' is identical to the rr' and gg')				
B'B'CC AA'x^4 C'g' Cr C'b' C'g' Cr Cb	0	-1	0	gluon (rg')
BBC'C' BB'x^4 C'g' Cr C'b' C'g' Cr Cb	0	1	0	gluon (rg')
B'B'CC AA'x^4 C'g' Cr C'b' Cg Cr C'b'	0	-1	0	gluon (rb')
BBC'C' BB'x^4 C'g' Cr C'b' Cg Cr C'b'	0	1	0	gluon (rb')
B'B'CC AA'x^4 Cg C'r' C'b' Cg Cr C'b'	0	-1	0	gluon (gb')
BBC'C' BB'x^4 Cg C'r' C'b' Cg Cr C'b'	0	1	0	gluon (gb')
B'B'CC AA'x^4 Cg C'r' Cb Cg C'r' C'b'	0	-1	0	gluon (r'g)
BBC'C' BB'x^4 Cg C'r' Cb Cg C'r' C'b'	0	1	0	gluon (r'g)
B'B'CC AA'x^4 Cg C'r' Cb C'g' C'r' Cb	0	-1	0	gluon (r'b)
BBC'C' BB'x^4 Cg C'r' Cb C'g' C'r' Cb	0	1	0	gluon (r'b)
B'B'CC AA'x^4 C'g' Cr Cb C'g' C'r' Cb	0	-1	0	gluon (g'b)
BBC'C' BB'x^4 C'g' Cr Cb C'g' C'r' Cb	0	1	0	gluon (g'b)
ABC'C' x^6 or D'C x^7	0	0	-0.5	Higgs
A'B'CC x^6 or DC' x^7	0	0	0.5	Higgs
x^8	0	0	0	Scalar particle

[1] *The gluon has two alternative methods of construction. For the alternative method, replace B'B'CC by ADB'C' in the LH spin forms and replace BBC'C' by A'D'BC in the RH spin forms*
where n^4 *= any n pairs of preons from AA' or BB' or CC' or DD'*

Table 11: Twenty preons (tau and tau neutrino)

Preons	Electric charge	Spin	Weak isospin	Particle name
ACx^9	-1	-0.5	-0.5	LH tau-
BCx^9	-1	0.5	0	RH tau-
B'Cx^9	0	-0.5	0	LH tau antineutrino
BC'x^9	0	0.5	0	RH tau neutrino
BD'x^9	0	0.5	-0.5	RH tau antineutrino
B'Dx^9	0	-0.5	0.5	LH tau neutrino
B'C'x^9	1	-0.5	0	LH tau+

A'C'x^9	1	0.5	0.5	RH tau+
non-Standard Model				
x^{10}	0	0	0	neutral particle
ABC'C' x^8 or D'Cx^9	0	0	-0.5	Higgs-like particle (5/4 higgs)
A'B'CC x^8 or DC'x^9	0	0	+0.5	Higgs-like particle (5/4 higgs)

where x^n = any n pairs of preons from AA' or BB' or CC' or DD'

Table 12: Three hexacolour sub-preons plus three preons (up quark and down quark)

Preons and sub-preons	Electric charge	Spin	Weak isospin	Particle Colour	Particle name
B' C C C'r' Cg Cb	-2/3	-0.5	0	r'	LH antiup
B' C C Cr C'g' Cb	-2/3	-0.5	0	g'	LH antiup
B' C C Cr Cg C'b'	-2/3	-0.5	0	b'	LH antiup
B C D' C'r' Cg Cb	-2/3	0.5	-0.5	r'	RH antiup
B C D' Cr C'g' Cb	-2/3	0.5	-0.5	g'	RH antiup
B C D' Cr Cg C'b'	-2/3	0.5	-0.5	b'	RH antiup
A C'g' Cr C'b' x^1	-1/3	-0.5	-0.5	r	LH down
A Cg C'r' C'b' x^1	-1/3	-0.5	-0.5	g	LH down
A C'g' C'r' Cb x^1	-1/3	-0.5	-0.5	b	LH down
B C'g' Cr C'b' x^1	-1/3	0.5	0	r	RH down
B Cg C'r' C'b' x^1	-1/3	0.5	0	g	RH down
B C'g' C'r' Cb x^1	-1/3	0.5	0	b	RH down
B' Cg Cb C'r' x^1	1/3	-0.5	0	r'	LH antidown
B' C'g' Cb Cr x^1	1/3	-0.5	0	g'	LH antidown
B' Cg C'b' Cr x^1	1/3	-0.5	0	b'	LH antidown
A' Cg Cb C'r' x^1	1/3	0.5	0.5	r'	RH antidown
A' C'g' Cb Cr x^1	1/3	0.5	0.5	g'	RH antidown
A' Cg Cr C'b' x^1	1/3	0.5	0.5	b'	RH antidown
B' C' D Cr C'g' C'b'	2/3	-0.5	0.5	r	LH up
B' C' D C'r' Cg C'b'	2/3	-0.5	0.5	g	LH up
B' C' D C'r' C'g' Cb	2/3	-0.5	0.5	b	LH up
B C' C' Cr C'g' C'b'	2/3	0.5	0	r	RH up
B C' C' C'r' Cg C'b'	2/3	0.5	0	g	RH up
B C' C' C'r' C'g' Cb	2/3	0.5	0	b	RH up

where x^1 = any one pair of preons from AA' or BB' or CC' or DD'.

Table 13: Three hexacolour sub-preons plus eleven preons (charm quark and strange quark)

Preons and sub-preons	Electric charge	Spin	Weak isospin	Particle Colour	Particle name
B’ C C C’r’ Cg Cb x^4	-2/3	-0.5	0	r'	LH anticharm
B’ C C Cr C’g’ Cb x^4	-2/3	-0.5	0	g'	LH anticharm
B’ C C Cr Cg C’b’ x^4	-2/3	-0.5	0	b'	LH anticharm
B C D' C'r' Cg Cb x^4	-2/3	0.5	-0.5	r'	RH anticharm
B C D' Cr C’g’ Cb x^4	-2/3	0.5	-0.5	g'	RH anticharm
B C D' Cr Cg C’b’ x^4	-2/3	0.5	-0.5	b'	RH anticharm
A C'g' Cr C'b' X^5	-1/3	-0.5	-0.5	r	LH strange
A Cg C'r' C'b' X^5	-1/3	-0.5	-0.5	g	LH strange
A C'g' C'r' Cb X^5	-1/3	-0.5	-0.5	b	LH strange
B C'g' Cr C'b' X^5	-1/3	0.5	0	r	RH strange
B Cg C'r' C'b' X^5	-1/3	0.5	0	g	RH strange
B C'g' C'r' Cb X^5	-1/3	0.5	0	b	RH strange
B' Cg Cb C'r' X^5	1/3	-0.5	0	r'	LH antistrange
B' C'g' Cb Cr X^5	1/3	-0.5	0	g'	LH antistrange
B' Cg C'b' Cr X^5	1/3	-0.5	0	b'	LH antistrange
A' Cg Cb C'r' X^5	1/3	0.5	0.5	r'	RH antistrange
A' C'g' Cb Cr X^5	1/3	0.5	0.5	g'	RH antistrange
A' Cg C'b' Cr X^5	1/3	0.5	0.5	b'	RH antistrange
B’ C’ D Cr C’g’ C’b’ x^4	2/3	-0.5	0.5	r	LH charm
B’ C’ D C’r’ Cg C’b’ x^4	2/3	-0.5	0.5	g	LH charm
B’ C’ D C’r’ C’g’ Cb x^4	2/3	-0.5	0.5	b	LH charm
B C’ C’ Cr C’g’ C’b’ x^4	2/3	0.5	0	r	RH charm
B C’ C’ C’r’ Cg C’b’ x^4	2/3	0.5	0	g	RH charm
B C’ C’ C’r’ C’g’ Cb x^4	2/3	0.5	0	b	RH charm

where x^n = any n pairs of preons from AA’ or BB’ or CC’ or DD’.

Table 14: Three hexacolour sub-preons plus nineteen preons (top quark and bottom quark)

Preons and sub-preons	Electric charge	Spin	Weak isospin	Particle Colour	Particle name
B’ C C C’r’ Cg Cb x^8	-2/3	-0.5	0	r'	LH antitop
B’ C C Cr C’g’ Cb x^8	-2/3	-0.5	0	g'	LH antitop
B’ C C Cr Cg C’b’ x^8	-2/3	-0.5	0	b'	LH antitop
B C D' C'r' Cg Cb x^8	-2/3	0.5	-0.5	r'	RH antitop
B C D' Cr C’g’ Cb x^8	-2/3	0.5	-0.5	g'	RH antitop
B C D' Cr Cg C’b’ x^8	-2/3	0.5	-0.5	b'	RH antitop
A C'g' Cr C'b' X^9	-1/3	-0.5	-0.5	r	LH bottom
A Cg C'r' C'b' X^9	-1/3	-0.5	-0.5	g	LH bottom
A C'g' C'r' Cb X^9	-1/3	-0.5	-0.5	b	LH bottom
B C'g' Cr C'b' X^9	-1/3	0.5	0	r	RH bottom

B Cg C'r' C'b' X^9	-1/3	0.5	0	g	RH bottom
B C'g' C'r' Cb X^9	-1/3	0.5	0	b	RH bottom
B' Cg Cb C'r' X^9	1/3	-0.5	0	r'	LH antibottom
B' C'g' Cb Cr X^9	1/3	-0.5	0	g'	LH antibottom
B' Cg C'b' Cr X^9	1/3	-0.5	0	b'	LH antibottom
A' Cg Cb C'r' X^9	1/3	0.5	0.5	r'	RH antibottom
A' C'g' Cb Cr X^9	1/3	0.5	0.5	g'	RH antibottom
A' Cg C'b' Cr X^9	1/3	0.5	0.5	b'	RH antibottom
B’ C’ D Cr C’g’ C’b’ x^8	2/3	-0.5	0.5	r	LH top
B’ C’ D C’r’ Cg C’b’ x^8	2/3	-0.5	0.5	g	LH top
B’ C’ D C’r’ C’g’ Cb x^8	2/3	-0.5	0.5	b	LH top
B C’ C’ Cr C’g’ C’b’ x^8	2/3	0.5	0	r	RH top
B C’ C’ C’r’ Cg C’b’ x^8	2/3	0.5	0	g	RH top
B C’ C’ C’r’ C’g’ Cb x^8	2/3	0.5	0	b	RH top

where x^n = any n pairs of preons from AA’ or BB’ or CC’ or DD’.

Some implications of the hexark and preon model #6

I Electric charge is determined by hexark and preon hexatones

In Model #6, the electric charge of an elementary particle is determined exactly by the hexatones of the preons in the particle (Tables 2 and 6). Blackness of hexatone equates to positive electric charge and whiteness equates to negative electric charge.

A red up quark has an equal number of red hexarks, antigreen and antiblue hexarks and so the red up quark’s redness is obtained directly from the red hexarks and indirectly from antigreen and antiblue. The net excess of the up quark’s antihexacolour hexarks provides an excess of dark hexatone and hence a positive electric charge.

The red down quark also has an equal number of red hexarks, antigreen and antiblue hexarks but the net excess of the hexacolour hexarks in the down quark provides an excess of white hexatone and hence a negative electric charge.

II Speed c, electric charge and hexatone

Hexarks have the potential to act in unison with other hexarks to achieve linear speed c for their aggregate body. This is similar to speed boat engines having greatest speed using twin, counterbalanced left and right torqued motors (Boatfix Inc., 2007). Individual hexarks have a chiral structure either screwing into or out of a hexacolour dimension and so although individual hexarks always maintain speed c, they do not have a linear speed c when in isolation. Preons are aggregates of hexarks but each preon and sub-preon has a net electric charge and a net imbalance with respect to hexacolour, that is, the hexarks in a single preon or sub-preon have a net loading which screws into hexacolour dimensions more than it screws out (or vice versa). Preons and sub-preons, as individual entities in isolation, possess speed c but not linear speed c, though they may unite with other preons to achieve linear speed c for an aggregate body.

It is important that preons do not have linear speed c because when particles interact, their preons are disaggregated. If preons could travel alone at linear speed c they could not stay in an interaction locality long enough to reform into new massive particles, especially in the case when virtual particles form with off-shell masses below their full masses. Such masses are assumed here to be caused by preons temporarily only part-fulfilling their proper combinations in massive particles.

Zero electric charge, and hence neutrality with respect to hexatone, is a necessary but not sufficient requirement for a particle to have linear speed c. The Z and the higgs are exceptions which have zero electric charge but also have rest mass. In Model #6, the reason that there can be these exceptions is the complexity of these particles in terms of the numbers of preons they contain. The Z (8 preons) and higgs (16 preons) have twice and four times the number of preons contained in a first generation up or down quark; because of the particular combinations of preons involved, the Z cannot make of itself two quarks and similarly the higgs cannot make of itself alone four quarks. Nevertheless, despite being point particles, they are not point fields and their field behaviour shows effects of their complex structures.

III **The Z and gluon**

The Z boson and the gluon both have the form (0, +/- 1, 0) where the parenthesis shows the properties: (electric charge, spin, weak isospin). The gluon has 16 preons and so has the amount to make four quarks (16 preons in total) if only it had the correct combination of preons, which it does not have (Tables 10, 12 to 14).

The aggregate preon contents of a LH red down quark plus a RH antired antidown quark is:

(r)(b') down quarks = (A C'g' Cr C'b' X^1)(A' Cg Cr C'b' X^1)

And the antimatter version is:
(r')(b) down quarks = (A' Cg C'r' Cb X^1)(A C'g' C'r' Cb X^1)

A particle which could simultaneously be rb' *and* r'b would require sixteen preons which have an aggregate with no net spin, which could not therefore be a gluon with only sixteen preons. But it could be formed by a higher generation gluon with more than sixteen preons. A gluon must include either BBC'C' preons (spin = +1) or B'B'CC preons (spin = -1). {Alternatively, B'B'CC could be replaced by ADB'C' in the LH spin forms and BBC'C' replaced by A'D'BC in the RH spin forms}. The same form of gluon that makes rg'+r'g could also, by rearrangement of the same preons and sub-preons, exactly make the rb'+r'b or the gb'+g'b gluons.

In Model #6, a red up quark is not purely hexared, but is hexared, antihexagreen and antihexablue, equally. An rr' pair of quarks is completely neutral in colour which could be reassembled into a gg' pair or a bb' pair of quarks using the same aggregate of preons and sub-preons.

The Z boson is less complex than the gluon as it has fewer preons, and it cannot form of itself alone two quarks and so cannot take the role of a colour force.

IV Hexacolour force and triple helix structure of the electron

The hexacolour charges on the hexarks need a force to attract and repel each other. Hexared attracts hexagreen and hexablue and antihexared, while hexared repels hexared. This has the same pattern as used by the force between quark colours. The hexacolour force is what binds together the hexarks within the elementary particles. In an electron, the hexarks all have the same sign of spin, and so every hexark screws into its hexacoloured brane with the same spin chirality. This causes the hexacoloured branes to intertwine to form a triple helix. The hexacoloured hexarks act like rungs of the triple helix ladder, or like the A-T and C-G connectors on the DNA double helix, but with spins continuously twisting the triple helix consistently one way. Whereas DNA has only two connectors, the triple helix has red with green, red with blue and green with blue connectors. Connecting the three hexacolour branes one with each other by their attractive hexacolour forces. Within the electron's say red hexacolour brane, the red - red repulsion stops the hexarks within the red brane from getting too close together. The triple helix is the intertwining of the collapsed extra dimensions from string theory, where the hexarks are like open strings where the first end attracts another hexark's end and the second end is screwing into its own hexacolour brane. Screwing into the brane causes the brane to twist and spin.

Left-handed electrons have spin -0.5 and the triple helix would spin one way, say counter clockwise, while the right handed electron has spin 0.5 and so the triple helix would spin clockwise.

The positrons likewise have left-handed and right-handed forms which cause their triple helixes to spin in opposite directions. The positrons have hexarks which all screw out of hexacolour branes (or into antihexacolour branes).

V Dark matter

There are non-Standard Model particles shown in Tables 7 to 11: Table 7 shows the neutral particle x^2, for example, AA'BB'. This particle has net zero properties of electric charge, spin and weak isospin and it may or may not be massless. Table 7 also shows the sterile neutrinos, which are potentially, as yet unobserved, mass carriers. They have no electric charge and no weak isospin, but have spin +/- 0.5. Each of these tables has a neutral particle and a higgs-like particle. Can the higgs-like particles be dark matter? They are all assumed to have mass, and to be lighter than the higgs in the lower generations and heavier than the higgs in higher generations.

The presence of the higgs particle was inferred at CERN by its decay products. There is no chance that the ¼ higgs can be found from its decay products as it is the lowest generation with no possible decay products. No elementary particle has fewer than four preons and the ¼ higgs only contains four preons.

The top quark is considerably heavier than the higgs boson is speculated to be close in mass to the 2-higgs.

VI Dark energy

Dark energy may be implemented by heavier generations decaying by interactions into the lighter generations. Lighter generations of fermions require more states than heavier generations as in this preon model, the electron has four preons, the muon has twelve preons and the tau has twenty preons. So there are more fermions existing with the passage of time and the decay of the higher generations. In this model there is no limit to the number of particle generations available, but it is assumed that the trend is decay from heavier generations of fermions to lighter ones which fits the trend of increasing entropy from fewer states to more states over time. If the higgs is the mass giver, and if there is a predominant generation of the higgs, then, when all the higgs fields of that generation have collapsed to lighter generations, there may be a transition in the universe as a lighter generation of higgs becomes the predominant mass giver in the universe.

VII Accelerated electrons radiating photons

The radiation of photons from accelerated electrons needs a source for the photons' preons. Photons contain four preons (96 hexarks) and those preons need to come only indirectly from an acceleration. In a preon model, particle interactions can be written similarly to chemical equations where the preons involved before the interaction exactly match the preons outgoing from the interaction. The preons can come from a collapsed vacuum field such as the neutral particle AA'BB' or a higgs-like field ABC'C', where the collapse is induced by the acceleration. Also, weak isospin must be conserved in Model #6 in particle interactions and that requires an elementary particle, for example the higgs or like a higgs, to inject or carry off the excess weak isospin. For example,

LH electron + ¼ higgs -> RH electron + photon

(-1, -0.5, -0.5) + (0, 0, 0.5) -> (-1, 0.5, 0) + (0, -1, 0)
Where parentheses are (electric charge, spin, weak isospin)

Each of the four particles has four preons:

ACBB' + A'B'CC -> BCAA' + B'B'CC

Where the preons before the interaction match the preons after the interaction.

An elementary particle keeps its chiral handedness, and hexark spin values, between particle interactions which allows the particle to store a hidden constant for spin so that an electron spin value recorded at interaction is determined exactly by its hidden spin constant value, the particle's helicity and the detector's orientation. The exactness of the interaction is not apparent because of the spinorial double cover of space.

VIII Gluon interactions

A similar interaction equation to that above, for a photon, involving a vacuum field can be written for a gluon changing a red quark into a green quark.

RH red up + gluon -> LH green up + higgs

(2/3, 0.5, 0, red) + (0, -1, 0, antired & green) -> (2/3, -0.5, 0.5, green) + (0, 0, -0.5)

Where parentheses are (electric charge, spin, weak isospin [, colours])
The quarks have four preons each while the gluon and higgs have sixteen preons each.

In terms of preon content the interaction is:

B C' C' Cr C'g' C'b' + B'B'CC AA'x^4 Cg C'r' Cb Cg C'r' C'b'

-> B' C' D C'r' Cg C'b' + D'C x^7

In order to match the incoming and outgoing preons in this interaction, some of the neutral x pairs of preons are not random. Four of the seven pairs of neutral preons on the r.h.s. of the interaction need to be AA'BB'CC'CC' and one of the four neutral pairs on the l.h.s. needs to be DD’ in order to balance the interaction. Also, the remaining three neutral x pairs need to match up on l.h.s. and r.h.s. This implies that not every gluon, even of the correct colour, is equally able to make an interaction occur.

Random neutral filler pairs, x, of preons may play a role in determining the values of the coupling constants. If the random x pairs do not make the interaction equation balance, there will be no interaction.

IX The Z boson interactions

Z is an elementary boson but is a mix of the W0 and B0 particles in the theory that gives rest mass to the Z. In Model #6, the gluon boson also has a mix of particles and yet it does not possess rest mass. The photon has only the minimum number of preons so cannot be a mix of other particles and it has no rest mass. The pattern would fit better if the Z, like the photon and gluon, had no rest mass.

A gluon is in the same generation as the higgs and could differ from the higgs by as little as one preon out of the sixteen they each contain:

Gluon (red/antired) = BBC’C’ x^6

Higgs = ABC’C’ x^6

Likewise, a Z can differ from a ½ higgs by only one preon out of eight.

Similar interactions could be written for the Z as for the photon, for example:

LH electron + Z -> RH electron + ½ higgs

(-1, -0.5, -0.5) + (0, 1, 0) -> (-1, 0.5, 0) + (0, 0, -0.5)
Where parentheses are (electric charge, spin, weak isospin)

The electrons have four preons each and the Z and ½ higgs each have eight preons:

AC x^1 + BBC’C’ x^2 -> BC x^1 + ABC’C’ x^2

It is suggested that the ½ higgs, which has no place in the Standard Model, may be a massive boson and that perhaps the Z has no rest mass, and weak isospin is conserved in particle interactions.

X The W boson and neutrino

The W- boson decays into a RH electron plus a RH antineutrino and also converts a LH up quark into a RH down quark and a RH up quark into a LH down quark. Interactions for these are seen below:

W- + ¼ higgs -> RH electron + RH antineutrino + neutral vacuum particle.

(-1, 1, 0) + (0, 0, -0.5) -> (-1, 0.5, 0) + (0, 0.5, -0.5) + (0, 0, 0)

BBx^3 + $D'Cx^1$ -> BCx^1 + $BD'x^1$ + x^2

where x^n is a completely neutral block of n preons.

The conversion of a LH red up quark to a RH red down quark needs to be shown as:

LH red up + W- -> RH red down + ½ higgs

(2/3, -0.5, 0.5) + (-1, 1, 0) -> (-1/3, 0.5, 0) + (0, 0, 0.5)

B' C' D Cr C'g' C'b' + BBx^3 -> B C'g' Cr C'b' x^1 + $DC'x^3$

One of the x^1 pairs of preons on the r.h.s. needs to be BB' for the interaction to balance.

The conversion of a RH red up quark to a LH red down quark needs to be shown as:

RH red up + W- -> LH red down + ½ higgs

(2/3, 0.5, 0) + (-1, -1, -1) -> (-1/3, -0.5, -0.5) + (0, 0, -0.5)

B C' C' Cr C'g' C'b' + AAx^3 -> A C'g' Cr C'b' x^1 + $ABC'C'x^2$

To cater for conversions of both LH and RH up quarks to down quarks requires there to be two forms of W-: spin minus and spin plus. The W- also has the necessary properties to enable a sterile neutrino to be formed:

W- + ¼ higgs -> LH electron + LH sterile antineutrino + neutral vacuum particle.

(-1, -1, -1) + (0, 0, 0.5) -> (-1, -0.5, -0.5) + (0, -0.5, 0) + (0, 0, 0)

AAx^3 + A'B'CC -> ACx^1 + $B'Cx^1$ + x^2

One of the x pairs in the r.h.s. needs to be AA' to make the interaction balance.

XI No neutrino-less double beta decay

Neutrino-less double beta requires the neutrino and antineutrino to be the same particle: a Majorana particle. The LH neutrino, in model #6, is $B'Dx^1$ and the RH antineutrino is $BD'x^1$ and these are not identical which would therefore not allow a neutrino-less double beta decay. (Despite x^1 being identical to an antimatter version of itself.)

XII Mass through interaction with the higgs field

In Model #6, weak isospin is conserved during particle interactions. Rest mass is acquired by a fermion or boson field interacting with the higgs field and the apparent weak isospins of the two fields varying because of the interplay of two fields each with different weak isospin. A left-handed fermion field with weak isospin of -0.5 could interact with a higgs field with weak isospin of +0.5 and the fermion field could appear to oscillate in weak isospin between -0.5 and 0. Likewise, the higgs field could appear to oscillate between 0.5 and 0. The net weak isospin of the two fields being zero. This can occur in a preon model because the fermions and the higgs contain many hexarks and each hexark has weak isospin of -1/48 so effects of individual hexarks in one field could be shielded by hexarks in the other field when the fields overlay. Also, as a hexark is string-like, it could contain an almost limitless content. So the Z boson could acquire mass in this way, but it is also possible that the ½ higgs boson and its rest mass are being overlooked and its rest mass is being wrongly attributed to the Z boson.

Neither the fermions nor the higgs change their preon compositions during their field interactions. A left-handed fermion retains the preons that define a left-handed fermion and a right-handed higgs retains the preons which define a right-handed higgs. A fermion particle could interact with a higgs particle and would necessarily change its preons from left-handed to right-handed format or vice versa. For example, a muon can do this.

XIII Supersymmetry

Many further possible combinations of hexarks, preons and sub-preons could have been listed. They have not because they do not match Standard Model particles or do not match elementary particles thought likely to be found soon, for example with spin 5/2 or electric charge -4. There is not a limit of three generations in this model. There is a limit depending on the finite total number of preons available in the universe. Also, if higher generations are generally decaying to lower generations, then there could be a de facto limit depending on what generations now remain present.

In this model there are no special pairings of partner elementary particles. There is no need for a special pairings of a fermion with its partner boson in order to link fermions to bosons. The link between fermions and bosons is through the same communal preons which can be used in either form of particle. Supersymmetric particles may be discovered but, in Model #6, the many potential new particles could exist because of new combinations of preons, without them needing to be fermion - boson partners.

XIV The missing antimatter

An asymmetry, in Model #6, is the association of L(eft) handed hexark chirality with hexacolour and the R(ight) handed hexarks with antihexacolour. It does not appear that 2^8 = 256 hexarks, which could apply if hexacolour and antihexacolour were independent of L / R chirality, gives a working model for the particles in the universe. This suggests a much earlier phase of the universe may have existed before this symmetry was broken. The earlier phase may have long preceded the Big Bang or alternatively long preceded the current cycle of the universe in Penrose's Cyclical Conformal Cosmology (CCC) which simply has matter in the universe changing from wholly bosonic form at nodes of the cycle and mixed bosonic an fermionic form other than at the nodes. The CCC does not imply any change in hexark or in preon structures between cycles. This asymmetry is analogous to the problem of the missing antimatter in the universe: there may be missing types of hexarks due to an evolutionary process which has eschewed them. Just as some elementary particles have specialised forms with specific combinations of preons, the universe may have evolved a specialised form. In preon models, there is no missing antimatter for elementary particles; every preon and sub-preon in Model #6, and every elementary particle, has an equal number of matter (L and R) and antimatter (L' and R') hexarks. Similarly, the asymmetry of hexacolour and chirality may prove to be explained more simply at an even more fundamental order of matter (say, heptarks).

In this preon model, antimatter is an ambiguous term if used out of context. The most fundamental matter in the model is in the L and R hexarks and the antimatter is in the L' and R' antihexark forms. All preons, sub-preons and particles are neutral with respect to this fundamental definition of matter/antimatter, despite the A', B', C' and D' being named as antipreons.

XV Neutrino oscillations

Below is an example of interactions which convert electron neutrinos into higher generation neutrinos. These interactions require the existence of sterile neutrinos.

Parentheses are: (electric charge, spin, weak isospin)

Higgs	+	LH electron neutrino	->	RH sterile muon neutrino	+	Z
(0, 0, -0.5)	+	(0, -0.5, 0.5)	->	(0, 0.5, 0)	+	(0, -1, 0)
16 preons	+	4 preons	->	12 preons	+	8 preons
ABC'C' x^6	+	B'Dx^1	->	BC' x^5	+	ADB'C' x^2

Followed by:

Higgs	+	RH sterile muon neutrino	->	LH tau neutrino	+	Z
(0, 0, 0.5)	+	(0, 0.5, 0)	->	(0, -0.5, 0.5)	+	(0, 1, 0)
16 preons	+	12 preons	->	20 preons	+	8 preons
A'B'CC x^6	+	BC' x^5	->	B'D x^9	+	A'D'BC x^2

One of the neutral x pairs on the r.h.s. need to be CC' and one of the pairs on the l.h.s. needs to be DD' to make the interaction balance.

XVI Next model for preons

It is likely that Model #6 will need to be modified to accommodate the production of fractional electric charges at or near absolute zero temperature in the Fractional Quantum Hall Effect (Pan et al, 2003). This change could involve having many more hexarks in a preon than 24 which would decrease the smallest electrical charge on a single hexark, which is + or - 1/48 in Model #6, to + or - 1/(2n) where n is the number of hexarks per preon. Also, preons A and B may need to be sub-divisible at zero temperature similar to the way in which Preon C has been sub-divided into three sub-preons.

Although it has not been achieved in Model #6, it would facilitate particle interactions if all or at least some neutral preon pairs, x^1, were interchangeable, for example if AA' were to equal

BB'. It is recognised that a better configuration of preon contents, in terms of the particular hexarks they contain or the number of preons existing, might be found. The notion of the hexarks, however, is thought to be more durable as it leads to an explanation of electric charge and for the structure of the electron, despite the hexarks being one layer further removed from us than the preons.

Summary

The paper shows a model for building all Standard Model elementary particles, and modelling interactions, from four neutral-colour preons and three hexacoloured sub-preons, plus their antipreons. Each preon is comprised of 24 hexarks selected from a total of 24 different hexarks and their 24 antimatter versions. Each hexark has chiral values of fundamental properties of elementary particles. Elementary particles are formed when preons combine, ranging from say a left-handed electron with four preons, say ACAA', to a right-handed red top quark with nineteen preons plus three sub-preons, for example, BC'C'CrC'g'C'b'AA'BB'CC'AA'BB'CC'AA'BB' (Tables 7 to 14).

Implications of the model are that the electric charge is not fundamental but depends on the net excess of hexacolour over antihexacolour in a particle, that is, the hexatone of a particle (Section I). Hexacolour is the colour charge on a hexark and there are three hexacolours mirroring the three quark colours. Any quark has a mixture of hexacolours so that a red quark is not purely hexared. Therefore the three colour branes need to be seen as mixtures of three, more fundamental, hexacolour branes.

The hexarks have hexacolour charges which by analogy with art colour theory can be separated into hue (colour) and tone (greyness). The hue is what determines a quark colour and the tone is what determines a particle's electric charge. The tone of a hexark is quantised into + or -1/48, i.e. black or white, respectively (Table 6).

Preons have the potential to act in unison with other preons to achieve linear speed c for their aggregate body. This is similar to speed boat engines having greatest speed using twin, counterbalanced left and right torqued motors. A preon alone will move non-linearly at speed c but will not achieve linear speed c just as a single torque propeller will cause a rudderless boat to move in circles (Section II).

There is a hexacolour force between hexarks which holds the hexarks in place together within an elementary particle. This force within the electron gives it a continuously twisting, triple helix structure made from intertwining hexacolour branes (Section IV).

Preon contents for all elementary particles are suggested and include the higgs, dark matter and completely neutral vacuum particles. Some extra particles are constructible such as the

¼ higgs, ½ higgs, 2-higgs and the neutral x^n particles (Section V). Many elementary particles may be constructed (not shown) which do not seem to be found in nature, such as with spin 9/2 or with electric charge -3/2 (Section XIII).

There is an implied involvement of the higgs or higgs-like particles in many particle interactions, for example in an electron radiating a photon (Section VII). Higgs-like particles are implicated as present in some gluon interactions assuming that weak isospin is conserved in particle interactions even though it is not conserved during field interactions (Section VIII). The photon is given preon contents, in Model #6, and these preons need to come from the vacuum as a say ¼ higgs or as a neutral vacuum particle when photons are being repeatedly radiated by an electron. Similarly the ½ higgs is a contributory party in interactions involving the Z boson and it is a possible implication that the Z boson has no rest mass. The ½ higgs, being a silent partner in the same interactions as the Z, has the rest mass that may possibly be being wrongly attributed to the Z (Section IX). The ½ higgs is also implicated in W interaction with the neutrinos, electrons and with quarks (Section X).

In Model #6, the neutrino is not its own antiparticle and so is not a Majorana particle. Neutrino-less double beta requires the neutrino and antineutrino to be the same particle and so this will not happen in Model #6 (Section XI).

Fermion fields can interact with higgs fields to give mass because the fermions have multiple parts, for example the electron has 96 hexarks. Also, each hexark is a string-like object. Despite such field effects, with oscillation of weak isospin values, the fermion retains its identity as a particle of a particular handedness and can only participate in a particle interaction with its particular handedness (Section XII).

All elementary particles, and even the preons and sub-preons, contain as many matter as antimatter hexarks. In Model #6, there is an asymmetry such that hexacolour is only found on L and R' hexarks, while antihexacolour is only found on L' and R hexarks. What caused this suggested asymmetry in nature is unknown (Section XIV).

Model #6 can allow neutrino oscillations, but only if sterile neutrinos exist (Section XV).

In a particle interaction, the preons and sub-preons disaggregate and then reaggregate to form new particles but there is no need for individual preons to gain or lose hexarks. Incorporating the Fractional Quantum Hall Effect may, however, require that aspect of Model #6 to be reviewed (Section XVI).

There are more preons in higher generations of particles than in lower generations. A decrease in higher generation numbers of particles and increase in lower generation ones would increase the numbers of particles in existence and cause a need for more space for the extra fermions perhaps contributing to dark energy (Section VI).

References

Ahmad et al. (The SNO Collaboration) 2001. *"Measurement of charged current interactions produced by Boron-8 solar neutrinos at the Sudbury Neutrino Observatory"*. http://www.astro.cornell.edu/academics/courses/astro201/sun_neutrino.htm

Boatfix Inc. (2007) *"Propellers"* http://www.boatfix.com/how/props.html

Boyd, S. (2003). *"Neutrinos and the Case of the missing antimatter"* (online seminar slides). http://www2.warwick.ac.uk/fac/sci/physics/staff/academic/boyd/talks/coventry_probusclub_talk.pdf

Gurzadyan, V.G. and Penrose, R. (2010). *"Concentric circles in WMAP data may provide evidence of violent pre-Big-Bang activity"*. arXiv:1011.3706v1 [astro-ph.CO]

Harari, H. (1979). "*A Schematic Model of Quarks and Leptons*". Physics Letters B 86 (1): 83–86, and Shupe, M. A. (1979). "*A Composite Model of Leptons and Quarks*". Physics Letters B 86 (1): 87–92 and also the Wikipedia article: http://en.wikipedia.org/wiki/Harari-Schupe_preon_model

Pan,W. Stormer, H.L., Tsui, D.C., Pfeiffer, L.N., Baldwin, K.W., West, K.W. (2003). "*Fractional Quantum Hall Effect of Composite Fermions*". PRL 90, 016801 (2003). arXiv:cond-mat/0303429v1 [cond-mat.mes-hall]

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APPENDIX

Tables of the hexarks contained in the four neutral-colour preons: A, B, C and D and in their 'antimatter' versions: A', B', C' and D'

Table A: Preon Unit A: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin -1/2; and total weak isospin -1/2; total hexatone is - 1/2.

L - - - r	L - - - r	L - - - r	L - - - r
L - - - g	L - - - g	L - - - g	L - - - g
L - - - b	L - - - b	L - - - b	L - - - b
R' - - - r	R' - - - r	R' - - - r	R' - - - r
R' - - - g	R' - - - g	R' - - - g	R' - - - g
R' - - - b	R' - - - b	R' - - - b	R' - - - b

Table B: Preon Unit B: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin +1/2; and total weak isospin is zero; total hexatone is -1/2.

L - + - r	L - + + r	L - + - r	L - + + r
L - + - g	L - + + g	L - + - g	L - + + g
L - + - b	L - + + b	L - + - b	L - + + b
R' - + - r	R' - + + r	R' - + - r	R' - + + r
R' - + - g	R' - + + g	R' - + - g	R' - + + g
R' - + - b	R' - + + b	R' - + - b	R' - + + b

Table C: Preon Unit C: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin is zero; and total weak isospin is zero; total hexatone is -1/2.

L - - - r	L - - + r	L - + - r	L - + + r
L - - - g	L - - + g	L - + - g	L - + + g
L - - - b	L - - + b	L - + - b	L - + + b
R' - - - r	R' - - + r	R' - + - r	R' - + + r
R' - - - g	R' - - + g	R' - + - g	R' - + + g
R' - - - b	R' - - + b	R' - + - b	R' - + + b

Table D: Preon Unit D: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin is zero; and total weak isospin is +1/2; total hexatone is -1/2.

L - - + r	L - - + r	L - + + r	L - + + r
L - - + g	L - - + g	L - + + g	L - + + g
L - - + b	L - - + b	L - + + b	L - + + b
R’ - - + r	R’ - - + r	R’ - + + r	R’ - + + r
R’ - - + g	R’ - - + g	R’ - + + g	R’ - + + g
R’ - - + b	R’ - - + b	R’ - + + b	R’ - + + b

Table A’: Preon Unit A’: 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin +1/2; and total weak isospin +1/2; total hexatone is +1/2.

L’ + + + r’	L’ + + + r’	L’ + + + r’	L’ + + + r’
L’ + + + g’	L’ + + + g’	L’ + + + g’	L’ + + + g’
L’ + + +b’	L’ + + + b’	L’ + + + b’	L’ + + + b’
R + + + r’	R + + + r’	R + + + r’	R + + + r’
R + + + g’	R + + + g’	R + + + g’	R + + + g’
R + + + b’	R + + + b’	R + + + b’	R + + + b’

Table B’: Preon Unit B’: 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin -1/2; and total weak isospin is zero; Total hexatone is +1/2.

L’ + - - r’	L’ + - + r’	L’ + - - r’	L’ + - + r’
L’ + - - g’	L’ + - + g’	L’ + - - g’	L’ + - + g’
L’ + - - b’	L’ + - + b’	L’ + - - b’	L’ + - + b’
R + - - r’	R + - + r’	R + - - r’	R + - + r’
R + - - g’	R + - + g’	R + - - g’	R + - + g’
R + - - b’	R + - + b’	R + - - b’	R + - + b’

Table C’: Preon Unit C’: 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin is zero; and total weak isospin is zero; total hexatone is +1/2.

L’ + - - r’	L’ + - + r’	L’ + + - r’	L’ + + + r’
L’ + - - g’	L’ + - + g’	L’ + + - g’	L’ + + + g’
L’ + - - b’	L’ + - + b’	L’ + + - b’	L’ + + + b’
R + - - r’	R + - + r’	R + + - r’	R + + + r’
R + - - g’	R + - + g’	R + + - g’	R + + + g’
R + - - b’	R + - + b’	R + + - b’	R + + + b’

Table D’: Preon Unit D’: 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin is zero; and total weak isospin is -1/2; total hexatone is +1/2.

L’ + + - r’	L’ + + - r’	L’ + - - r’	L’ + - - r’
L’ + + - g’	L’ + + - g’	L’ + - - g’	L’ + - - g’
L’ + + - b’	L’ + + - b’	L’ + - - b’	L’ + - - b’
R + + - r’	R + + - r’	R + - - r’	R + - - r’
R + + - g’	R + + - g’	R + - - g’	R + - - g’
R + + - b’	R + + - b’	R + - - b’	R + - - b’

Tables of the hexarks contained in the three colour sub-units: Cr, Cg and Cb and in their ‘antimatter’ versions: C’r’, C’g’ and C’b’

Table Cr: Preon Cr: 4 red hexarks and 4 red antihexarks
Total electric charge is -1/6; total spin is zero; and total weak isospin is zero; total hexatone is -1/6.

L - - - r	L - - + r	L - + - r	L - + + r
R’ - - - r	R’ - - + r	R’ - + - r	R’ - + + r

Table Cg: Preon Cg: 4 green hexarks and 4 green antihexarks
Total electric charge is -1/6; total spin is zero; and total weak isospin is zero; total hexatone is -1/6.

L - - - g	L - - + g	L - + - g	L - + + g
R’ - - - g	R’ - - + g	R’ - + - g	R’ - + + g

Table Cb: Preon Cb: 4 blue hexarks and 4 blue antihexarks
Total electric charge is -1/6; total spin is zero; and total weak isospin is zero; total hexatone is -1/6.

L - - - b L - - + b L - + - b L - + + b
R’ - - - b R’ - - + b R’ - + - b R’ - + + b

Table 3C’r’: Preon C’r’: 4 antired hexarks and 4 antired antihexarks
Total electric charge is +1/6; total spin is zero; and total weak isospin is zero; total hexatone is +1/6.

L’ + - - r’ L’ + - + r’ L’ + + - r’ L’ + + + r’
R + - - r’ R + - + r’ R + + - r’ R + + + r’

Table C’g’: Preon C’g’: 4 antigreen hexarks and 4 antigreen antihexarks
Total electric charge is +1/6; total spin is zero; and total weak isospin is zero; total hexatone is +1/6.

L’ + - - g’ L’ + - + g’ L’ + + - g’ L’ + + + g’
R + - - g’ R + - + g’ R + + - g’ R + + + g’

Table C’b’: Preon C’b’: 4 antiblue hexarks and 4 antiblue antihexarks
Total electric charge is +1/6; total spin is zero; and total weak isospin is zero; total hexatone is +1/6.

L’ + - - b’ L’ + - + b’ L’ + + - b’ L’ + + + b’
R + - - b’ R + - + b’ R + + - b’ R + + + b’

A hexark’s electric charge is + or - 1/48; A hexark’s spin is + or - 1/48; A hexark’s weak isospin is + or - 1/48. A hexark’s hexatone is also + or - 1/48: r, g and b each have hexatone = -1/48 and r’, g’ and b’ each have hexatone = +1/48.