Models for quantum gravity, dark matter and dark energy using the Hexark and Preon Model #7

Austin J. Fearnley
Manchester
England
20 October 2015

Abstract

Quantum gravity, dark matter and dark energy has here been modelled using Hexark and Preon Model #7. Catalyst bosons stimulate a force exchange between fermions and/or between bosons. The photon, Z and gluon form a family of three generations. There are separate families of generations of higgs, W, dark boson and also the graviton. The third generation gluon, higgs, dark and graviton are all coloured in a similar way. Gravitons are in three generations. Gravitational QCD acts as an extremely weak third generation version of QCD while Gravitational QED acts as a weak first generation copy of QED. There is also a gravitational weak force which very weakly mimics the second generation Z force. Dark matter is a third generation dark boson as also is the higgs boson. Gravity is not wholly attractive but the coloured graviton (third generation) is a mainly attractive and dominant Gravitational QCD force on an intergalactic scale, as the strong force is a dominant attractive force within an atomic nucleus. The relative weakness of the gravitational force enables an attractive dominance to extend over a huge domain, but not an unlimited extent. The first generation gravitons enable a repulsive force to dominate outside the sphere of the attractive third generation graviton, just as the first generation photon enables different nuclei to repel one other electromagnetically. This first generation gravitational QED force gives rise, at a very large distance away, to dark energy.

Generations of elementary particles

The Hexark and Preon Model #6 (Fearnley, May 2015) has the higgs as a single family of different higgs geerations each with similar properties, except for their different masses. To accommodate the graviton into the preon model, the model needed tweaking to become model #7. One tweak was to add colour to the higgs boson of the third generation (that is, the higgs with mass 125 GeV/c^2), shown in Table 1. The graviton of the third generation also needed to have colour-anticolour in an identical format to the gluon and the higgs (and the dark boson). Generations 1 and 2 do not have complex enough preon structures to have the colour-anticolour property of the gluon.

The ¼ G graviton cannot be formed from the four preons of Preon model #6 but can be formed by removing Preon D and replacing it with Preon E which has the properties: electric charge = -0.5, spin = 0.5 and weak isospin = -0.5. The ¼ G is of the form AAB'E' with properties electric charge = 0, spin =-2 and weak isospin = -0.5. Preons make the fifth tier of particles with elementary particles being the fourth tier. The even more remote hexarks in the sixth tier appear to be more securely based than are the preons as they are an exhaustive cover of all combinations of different qualities of electric charge, spin, weak isospin and colour: every hexark having a unique combination of chiral attitudes to the different qualities. Colour is treated as a single quality in that particular respect as an individual hexark can have either red or green or blue or antired or antigreen or antiblue colour and so cannot mix its colour. The preons, on the other hand, are an attempt to give a minimum number of entities to be exchanged at particle interactions. A simpler basis than trying to handle the 24 hexarks (plus 24 more antihexarks) directly. The preons give a quantum structure to particles, but also do the hexarks, but it is easier to deal with a minimal number of building blocks or preons when this is possible, and it does seem to be possible in nature.

Table 1: Families of elementary particles

Generation	1	2	2	3	3
Number of preons per particle	4	8	12	16	20
				(all particles in this column have colour-anticolour)	
Quarks	down		strange		bottom
	up		charm		top
Leptons Electrons	electron		muon		tau
Neutrinos	electron neutrino		muon neutrino		tau neutrino
Bosons force bosons	photon	Z		gluon	
Weak boson	½ W ?	W		2W ?	
Higgs family	¼ higgs	½ higgs		higgs	
Gravitons	¼ G	½ G		G	
Dark matter	¼ dark	½ dark		dark	

The photon, Z and gluon are in three different generations gradually getting more complicated in structure allowing more properties for the higher generation particles. It is possible that the top and bottom quarks have colour and colour-anticolour. A fourth generation gluon, not shown in the table, could have colour-anticolour plus another colour-anticolour.

Gravity is not a wholly attractive force

Gravity is not a wholly attractive force as, for example, electrons are gravitationally repelled from electrons in the quantum gravity in preon model #7. Before placing the family of gravitons in their own row in Table 1 other forms of graviton were considered and found to be unworkable. For example, having a new quality of 'gravity' on a par with electric charge, spin and weak isospin. Or having the graviton as a single fourth or fifth generation particle. Direct attempts to place the graviton in a preon model failed. The decision to use a graviton family in its own row of Table 1 arose indirectly and quite accidentally when reviewing the force gauge boson family row. In creating preon model #6, obtaining a working preon model for the gauge boson family row was a success, but the spins of all the particles involved had to be correctly selected in order to give the correct interaction paths. At the time of making model #6 (May 2015) the success of getting a working model masked an unasked question of "what if the spins of all the particles involved are not just right for the gauge boson exchange?" On recently investigating that question, the answer arose that the graviton can be exchanged instead of the force boson.

Table 1 shows that each of the force bosons has a counterpart in one of the gravitons. The strong force is implemented by the gluon. The gluon is dominant over all other forces over a short distance, that is, within the atomic nucleus. Gravity is well known to be extremely weak compared to the other forces and also well known to have a spin of 2. The third generation graviton weakly mimics the strong force, acting through colour-anticolour interactions, as does the gluon. But the G graviton's range of dominance over the ranges of the ½ G (weak gravitational force) and ¼ G (EM gravitational force) is on a universal scale. Between loosely 10^{35} and 10^{40} times further than the atomic nucleus diameter puts the dominance of the G force well beyond our local galaxies and maybe for a sizeable chunk of the observable universe. Within the nucleus, the strong force holds together the quarks via its QCD colour force mechanism while QED is either overwhelmed. A weak mimicry of this QCD force, say a Gravitational QCD, holds quarks together gravitationally for an unknown but large portion of the universe. The first generation EM force repels nuclei away from one another when outside the dominant sphere of influence of the strong force. Equivalent but weaker gravitational first generation forces (1/4 G) will repel quarks using GQED (Gravitational QED) such as may explain dark energy in which case very distantly separated galaxies may be gravitationally repelling one another. Just how closely the gravitational forces match the three other forces in their behaviours is unknown. For example, could there be a weak gravitational equivalent of magnetism (Gravitational Magnetism)? Table 2 shows the different qualities, except for masses, of the different elementary particles. Unlike the gluon, the graviton has a non-zero value for the weak isospin. Similarly, so has the neutrino, and that can travel at or near the speed of light and is apparently unlimited in range. The gluon has colour-anticolour and still has speed c, so the graviton, G, also could have speed c. Spin 2 presumably is implicated in the graviton being so weak with presumably extremely small coupling constants in the three generations.

Table 2: Families of elementary particles and their fundamental properties

		Properties **(Electric charge, spin, weak isospin, colour)** na= not applicable, L=left-handed chirality [L and R notation is used very loosely here for all of spin, weak isospin, fermions and bosons.] Colour = red, green or blue Anticolour = antired, antigreen or antiblue	
Quarks	down, strange, bottom	L (-1/3, -1/2, -1/2, colour) R (-1/3, +1/2, 0, colour)	
	up, charm, top	L (+2/3, -1/2, 1/2, colour) R (+2/3, +1/2, 0, colour)	
Leptons	electron, muon, tau	L (-1, -1/2, -1/2, na) R (-1, +1/2, 0, na)	

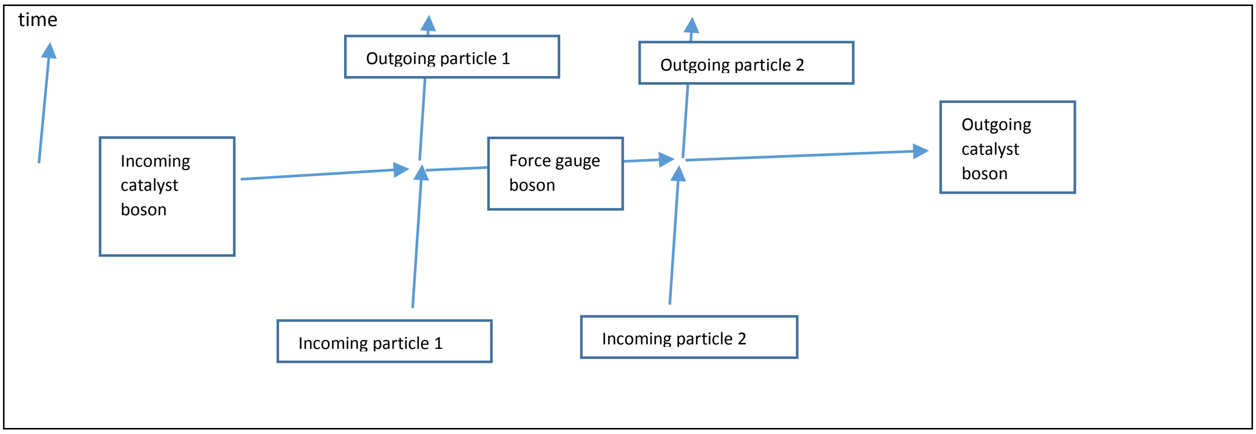
	electron neutrino, muon neutrino, tau neutrino	L (0, -1/2, +1/2, na) R (0, +1/2, 0, na) [if this R form exists]	
Bosons	photon, Z	L (0, -1, 0, na) R (0, +1, 0, na)	
	gluon	L (0, -1, 0, colour & anticolour) R (0, +1, 0, colour & anticolour)	
	¼ higgs, ½ higgs	L (0, 0, -0.5, na) R (0, 0, 0.5, na)	
	higgs	L (0, 0, -0.5, colour & anticolour) R (0, 0, 0.5, colour & anticolour)	
	¼ G, ½ G	L (0, -2, -0.5, na) R (0, +2, 0.5, na)	
	¼ G2, ½ G2	L (0, -2, 0.5, na) R (0, +2, -0.5, na)	
	G	L (0, -2, -0.5, colour & anticolour) R (0, +2, 0.5, colour & anticolour)	
	G2	L (0, -2, 0.5, colour & anticolour) R (0, +2, -0.5, colour & anticolour)	
	¼ dark, ½ dark	L (0, 0, 0, na) R (0, 0, 0, na)	
	dark	L (0, 0, 0, colour & anticolour) R (0, 0, 0, colour & anticolour)	

Bosons as catalysts for force boson exchanges

In this model, the electron does not spontaneously emit a photon but does so only on impact with a (say) higgs boson, normally of a lower generation (¼ higgs) than the higgs boson recently discovered (full higgs), and neither does the electron merely spontaneously absorb a photon but it simultaneously releases a ¼ higgs boson. If a left-handed electron is hit by a ¼ higgs- a photon+ is emitted; if a right-handed electron is hit by a photon+ then a ¼ G+ is emitted. A few examples of photon, Z and gluon boson exchanges are shown in this section. Also, some of the corresponding gravitational force exchanges are given.

In Figure A, a generalised diagram is shown for the exchange of a force boson between two particles. Note that some property of each particle changes at each interaction.

Figure A Generalised diagram for the exchange of a force gauge boson between two particles, involving two interactions



In Figure B, a Z boson is exchanged between two red down quarks. Particle 1 starts as a left-handed red down quark and finishes as a right-handed red down quark. Particle 2 starts as a right-handed red down quark and finishes as a left-handed red down quark. The incoming catalyst boson is a right-handed ½ higgs where the right handed refers to a positive weak isospin value. The outgoing boson catalyst is also a right-handed ½ higgs, so the ½ higgs acted like a catalyst and was released back into the environment to assist in more force boson exchanges.

In more detail, this force exchange can be treated as two separate interactions. First,

Incoming particle 1 + incoming catalyst boson → outgoing particle 1 + force boson.

And second,

Incoming particle 2 + force boson → outgoing particle 2 + outgoing catalyst boson.

For Figure B the particles and their qualities and their preons are for interaction 1:

Red down L + ½ higgs+ → Red down R + Z-

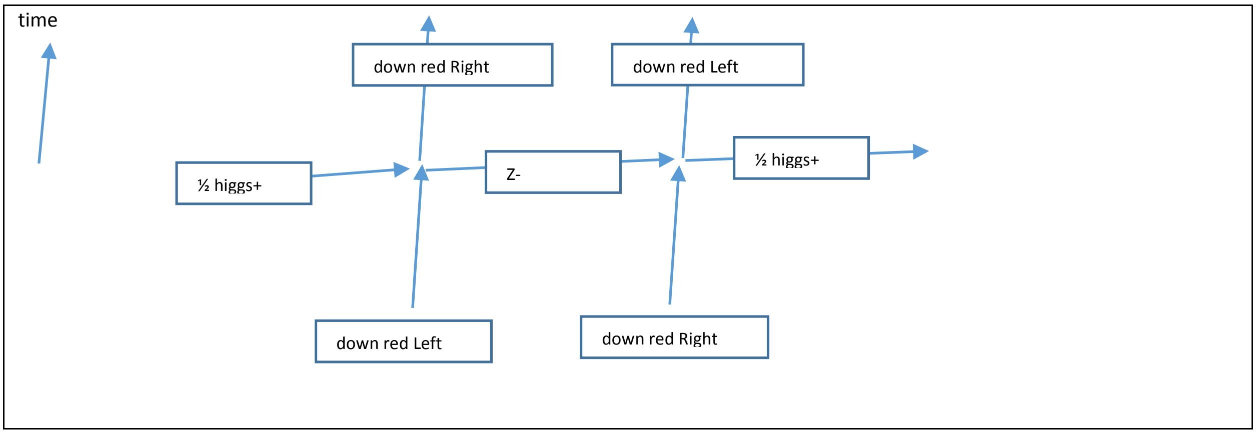
(-1/3, -0.5, -0.5, red) + (0, 0, 0.5) → (-1/3, 0.5, 0, red) + (0, -1, 0)

where parentheses are (electric charge, spin, weak isospin, colour [if appropriate])

The particles' preons are: ACrC'g'C'b'X + A'B'CCXX → BCrC'g'C'b'X + B'B'CCXX , where X can be AA' or BB' or CC'. The preons going into the interaction are identical to the preons coming out of the interaction (assuming one of the incoming X pairs of preons is BB' and one of the outgoing X pair is AA').

Interaction 2 is the reverse of interaction 1.

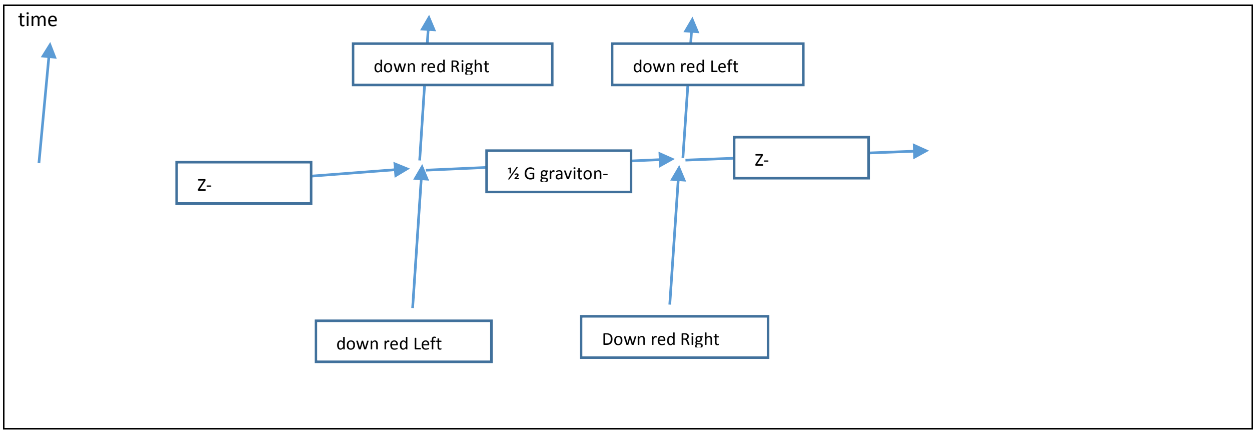
Figure B The exchange of a Z force gauge boson between two red down quarks



(See Table 3 for new Model #7 preon structures of particles covered in these interactions.)

Next, in Figure C, a graviton, ½ G, is shown exchanged between two red down quarks.

Figure C The exchange of a ½ G graviton between two red down quarks



For Figure B the particles and their qualities and their preons are for interaction 1:

Red down L + Z- → Red down R + ½ G-

(-1/3, -0.5, -0.5, red) + (0, -1, 0) → (-1/3, 0.5, 0, red) + (0, -2, -0.5)

where parentheses are (electric charge, spin, weak isospin, colour [if appropriate])

Particles' preons are: ACrC'g'C'b'X + B'B'CCXX → BCrC'g'C'b'X + AB'B'B'CCX , where X can be AA' or BB' or CC'. The preons going into the interaction are identical to the preons coming out of the interaction (assuming one of the incoming X pairs of preons is BB').

Interaction 2 is the reverse of interaction 1.

So the Z- boson acts as a catalyst for the exchange of a ½ G- graviton and is released back to the environment as a Z- after the second interaction.

Figures D and E show a gluon exchange and a G graviton exchange respectively.

For Figure D, interaction 1 is

Down red left + blue-antired higgs+ → down green right + blue-antigreen gluon-

(-1/3, -0.5, -0.5, red) + (0, 0, 0.5, br’) → (-1/3, 0.5, 0, green) + (0,-1, 0, bg’)

ACrC’g’C’b’X + A’B’CC[C’r’C’g’Cb][C’r’CgCb]XXXXX →

BC’r’CgC’b’X + B’B’CC[C’r’C’g’Cb][CrC’g’Cb]XXXXX

Preons are conserved in interaction 1 (assuming one of the outgoing X pairs of preons is AA’ and one of the incoming X pairs is BB’). The blue combination of sub-preons: C’r’C’g’Cb is common to both sides of interaction 1. The incoming red and antired combination of sub-preons is [CrC’g’C’b’][C’r’CgCb] which can be rearranged as [CrCgCb][C’r’C’g’C’b’] which is identical in sub-preon content to CC’. Similarly, the outgoing green and antigreen combination of sub-preons is identical also to CC’, so both sides of the interaction balance with respect to colour.

Interaction 2 is the reverse of interaction 1.

The blue-antired higgs+ is the incoming and outgoing boson catalyst for the force exchange while the blue-antigreen gluon- is exchanged between the red and the green down quarks. The two quarks exchange their colours and also change spin handedness.

Figure D The exchange of a blue-antigreen gluon- between two down quarks

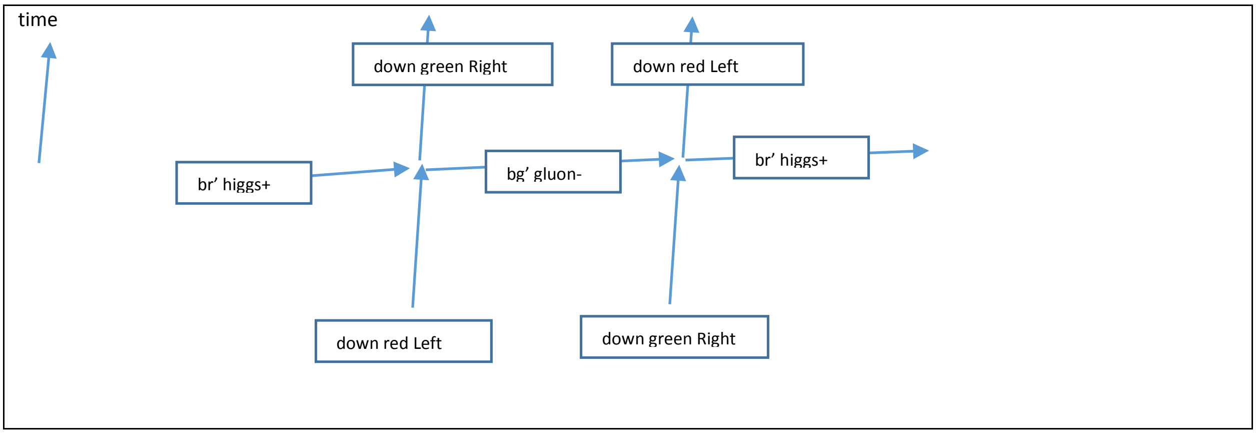
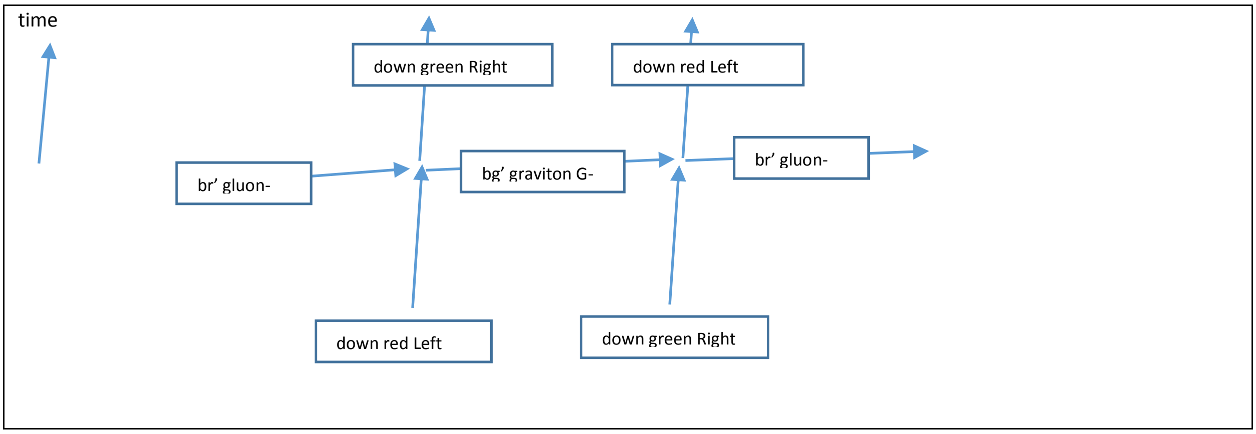


Figure E shows an instance of a blue-antigreen graviton being exchanged between a down red quark and a down green quark.

Figure E The exchange of a blue-antigreen graviton- between two down quarks



For Figure E, interaction 1 is:

down red left + blue-antired gluon- → down green right + blue-antigreen graviton G-

(-1/3, -0.5, -0.5, red) + (0, -1, 0, br') → (-1/3, 0.5, 0, green) + (0,-2, -0.5, bg')

ACrC'g'C'b'X + B'B'CC[C'r'C'g'Cb][C'r'CgCb]XXXXX →

BC'r'CgC'b'X + AB'B'B'CC[C'r'C'g'Cb][CrC'g'Cb]XXXX

Preons are conserved in interaction 1 (assuming one of the incoming X pairs of preons is BB')

Interaction 2 is the reverse of interaction 1.

The blue-antired gluon- is the incoming and outgoing boson catalyst for the graviton exchange while the blue-antigreen graviton- is exchanged between the red and the green down quarks. The two quarks exchange their colours and also change spin handedness.

More diagrams showing graviton exchange

In this section some interactions are shown without commentary but where there is a more interesting interaction, not previously treated in the text, such as with the W-, up quark and neutrino, then a commentary is given. Note that interactions 1 and 2 in the various Figures can be swapped around in a mix and match style, and also the interactions are time reversible which can multiply the number of different particles undergoing force exchanges able to be illustrated by these interactions. All data in this section comply with elementary particle qualities and their preon content in Model #7. Table 3 gives preon structures of particles covered in these interactions which have been revised for Model #7.

Figure F The exchange of a ½ G graviton- between an electron and a red down quark

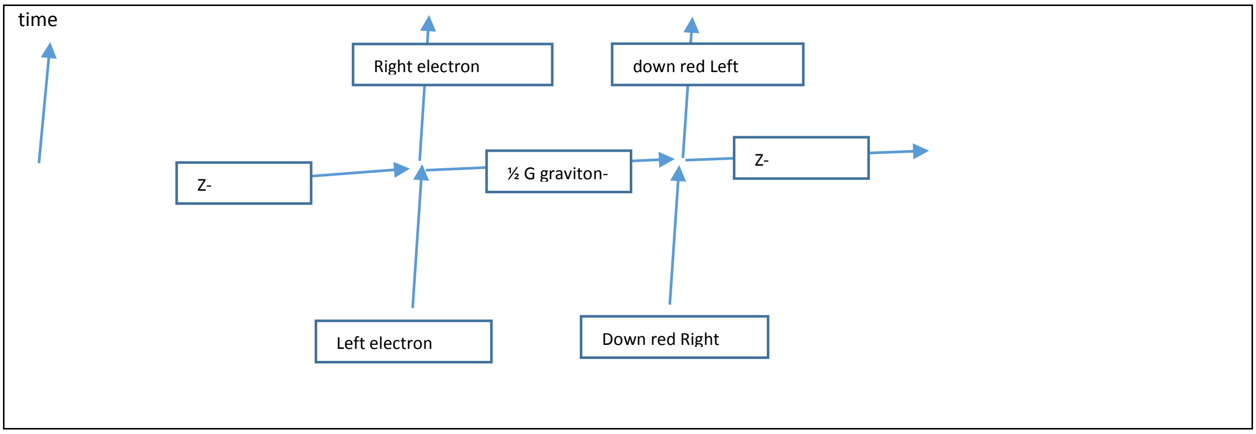
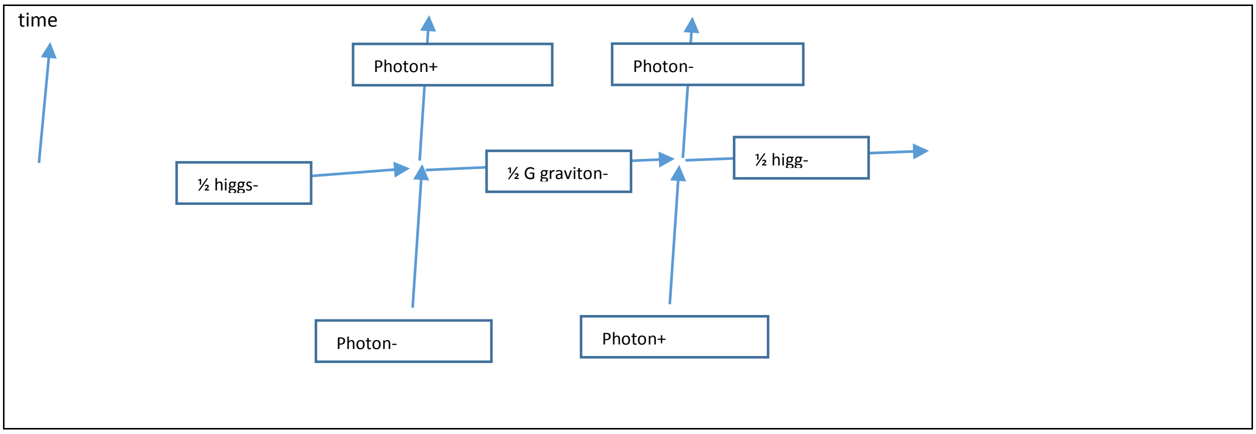


Figure G The exchange of a ½ G graviton- between two photons



The ¼ G- graviton could be used in Figure G instead of the ½ G- as the exchange boson while the ¼ H- would act as the catalyst boson. Alternatively, the G- graviton could act as the exchange boson with the higgs- acting as the catalyst boson.

Figure H The exchange of a ½ G graviton- between two Z bosons

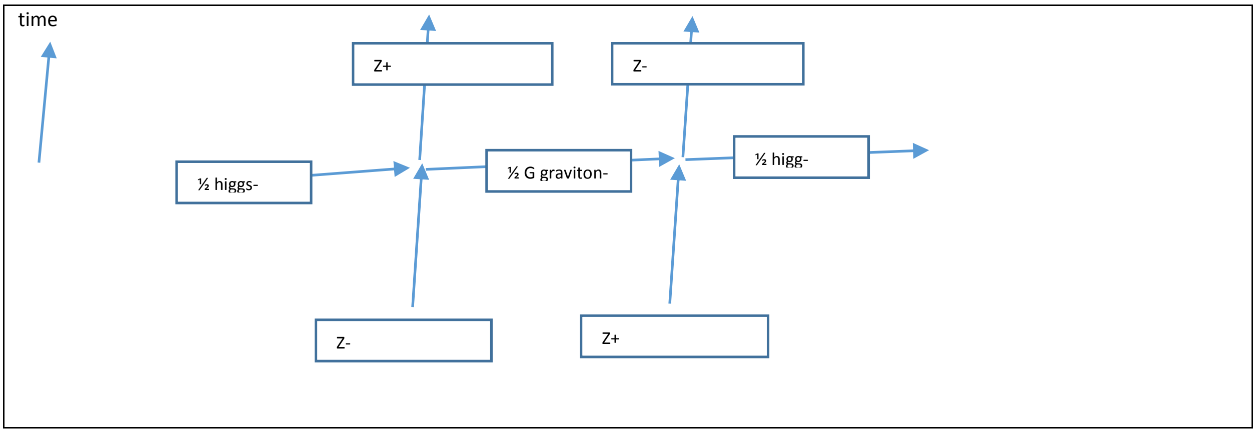
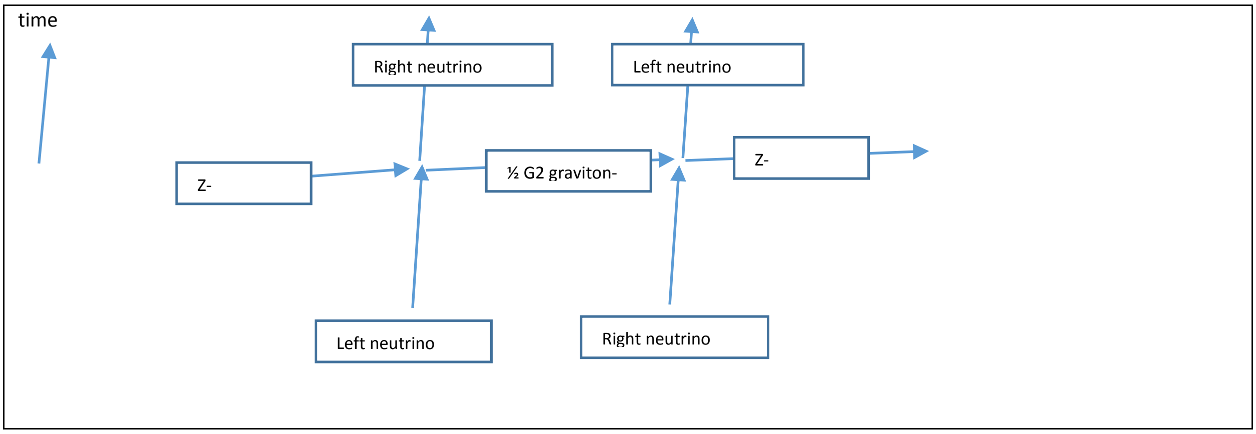


Figure J The exchange of a ½ G2- graviton- between two neutrinos



For Figure J, Interaction 1, particle 1 is a left-hand neutrino (CE'X) which is converted to a right handed hypothetical sterile neutrino (BC'X), while the incoming boson catalyst, Z-, is B'B'CCXX. A new graviton, ½ G2- (B'B'B'CCCCE'), is the exchange boson with properties (0, -2, 0.5).

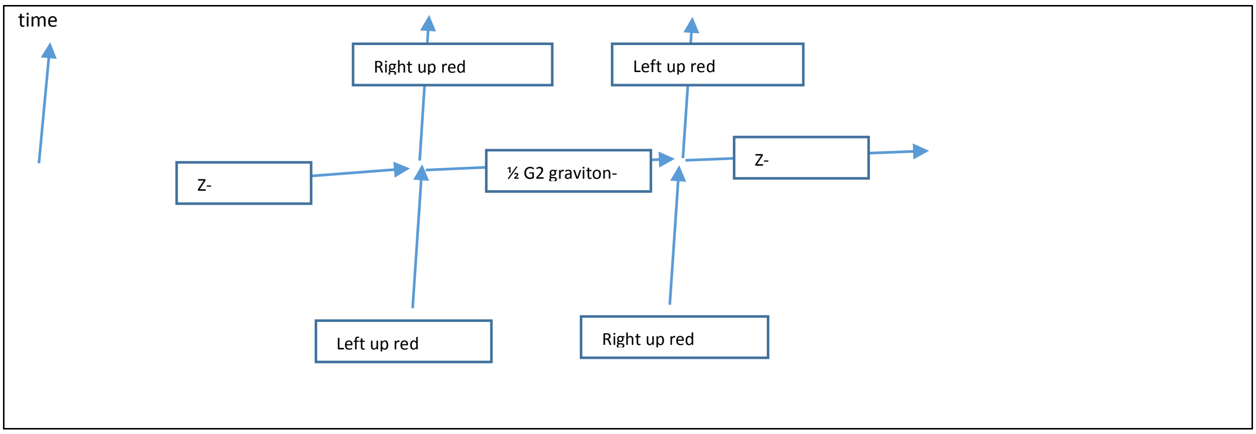
The Interaction 1 path is: CE'X + B'B'CCXX → BC'X + B'B'B'CCCCE', which balances incoming preons with outgoing preons.

Particle properties are: (0,-0.5, 0.5) + (0, -1, 0) → (0, 0.5, 0) + (0, -2, +0.5)

Interaction 2 is the reverse of interaction 1.

The graviton ½ G2 has properties (0, -2, 0.5) which has a different weak isospin to ½ G which has properties (0, -2, -0.5). Where parentheses are (electric charge, spin, weak isospin). Note that the right-hand neutrino might not exist.

Figure K The exchange of a ½ G2- graviton- between two red up quarks



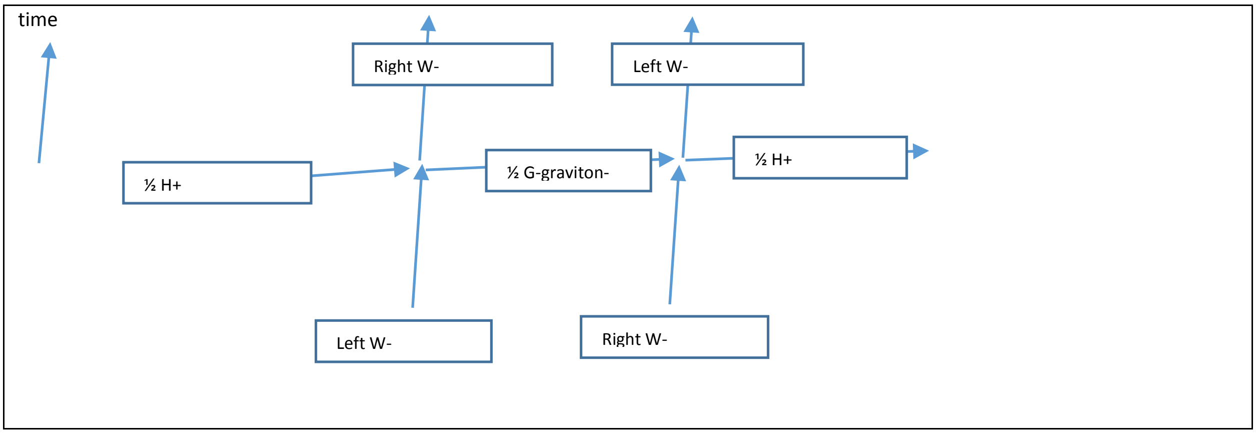
For Figure K, Interaction 1, particle 1 is a left-handed red up quark (E'CrC'g'C'b'X) which is converted to a right-handed red up (BC'C'CrC'g'C'b'), while the incoming boson catalyst, Z- , is B'B'CCXX. A ½ G2-graviton (B'B'B'CCCCE'), is the exchange boson.

The Interaction 1 path is: E'CrC'g'C'b'X + B'B'CCXX → BC'C'CrC'g'C'b' + B'B'B'CCCCE', which balances the incoming and outgoing preons assuming the incoming preons have BB' as one of the X pairs of preons.

Particle properties are: (2/3,-0.5, 0.5) + (0, -1, 0) → (2/3, 0.5, 0) + (0, -2, 0.5)

Interaction 2 is the reverse of interaction 1.

Figure L The exchange of a ½ G- graviton between two W- bosons



For Figure L, Interaction 1, particle 1 is a left-handed W- (AAXXX) which is converted to a right-handed W- (BBXXX), while the incoming boson catalyst, ½ H+, is A'B'CCXX. A ½ G- graviton (AB'B'B'CCX), is the exchange boson.

The Interaction 1 path is: AAXXX + A'B'CCXX → BBXXX + AB'B'B'CCX, which balances the incoming and outgoing preons assuming that the incoming preons have (BB')(BB') as two of the X pairs of preons and the outgoing preons have AA' as one of the X pairs of preons.

Particle properties are: (-1,-1,-1) + (0, 0, 0.5) → (-1, 1, 0) + (0, -2, -0.5)

Interaction 2 is the reverse of interaction 1.

Figure M The exchange of a G- graviton between two gluons

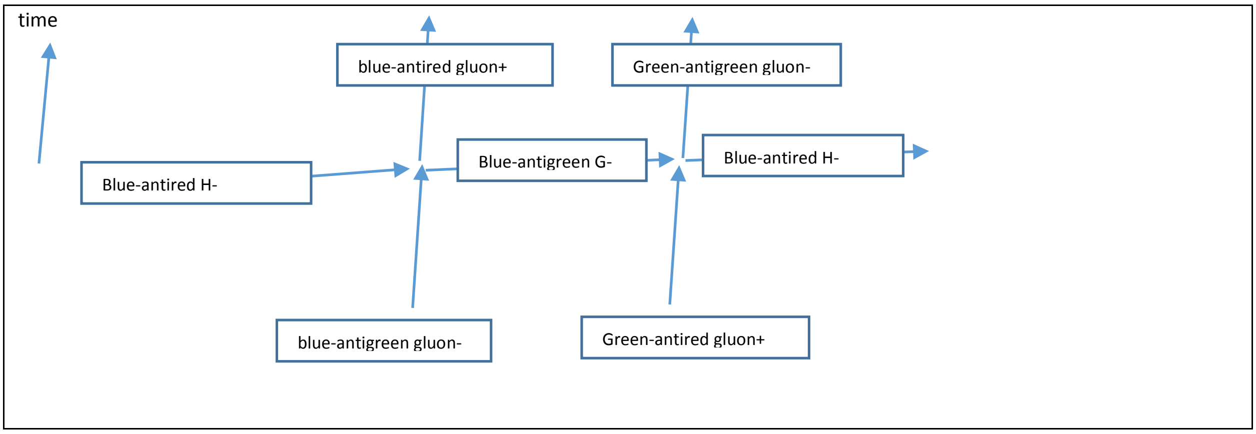
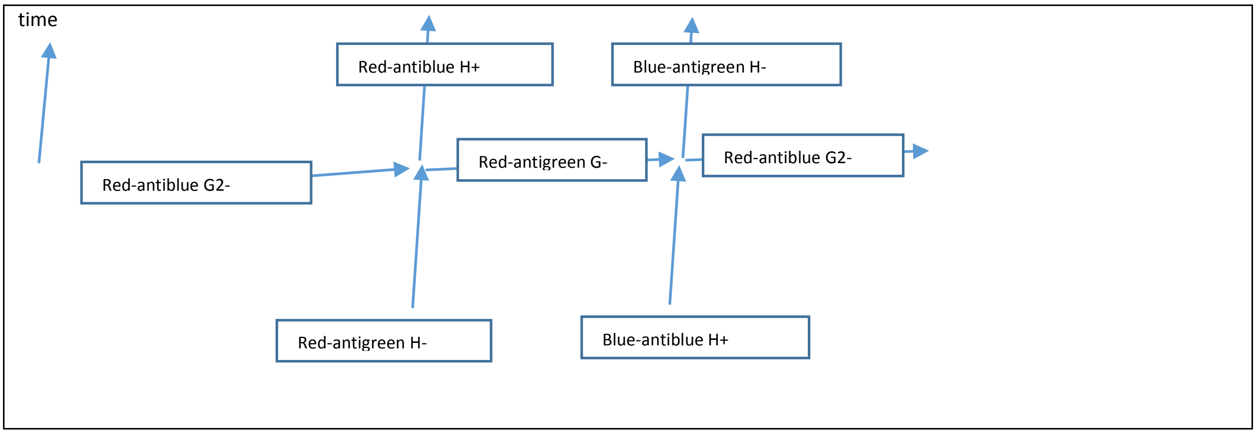


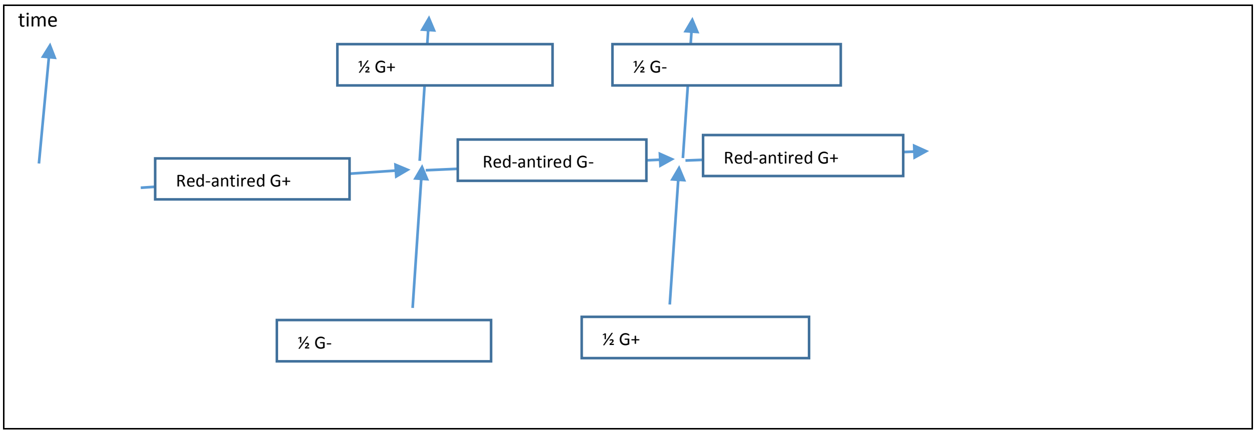
Figure N The exchange of a G- graviton between two Higgs bosons



In Figure N a G2- graviton is being used as a catalyst boson, which is an approach not previously modelled in this paper. Different paths could have been chosen, for example if G- had been used as the catalyst boson, the exchange graviton would have been possibly a G3- graviton (preon structure AAAB'C'C'X) with weak isospin = -1.5, if that path and graviton are admissible. Maybe it is not surprising that the graviton exchange between two higgs bosons has thrown up an intricacy because the higgs boson also has a role of a 'mass giver'.

The approach of using gravitons as catalyst bosons will also be used in Figure P for the exchange of a graviton between gravitons.

Figure P The exchange of a graviton between two gravitons



Hexark and Preon Models #6 and #7

Hexark and Preon Model #6 was completed and published in May 2015. That model had recently been revised to include an extra preon, Preon D, to cater for the structures of the up quarks and the neutrino, but that model was not designed to cater for the graviton. Model #6 has since proved inadequate to create a model for the ¼ G graviton, but replacing preon D by preon E in a new Preon Model #7 provides a suitable basis for constructing all gravitons and all other particles. Including the graviton has also pointed to other necessary changes. In particular, the third generation member of the higgs family needed the addition of colour-anticolour components, which made it like the gluon with respect to colour. Similarly, the dark boson obtains colour-anticolour in the third generation boson. See Table 3 for the extensions to the preon model #6 which are needed for interactions covered in this paper. A separate paper for the full Model #7 will be published as soon as possible.

Table 3: Hexark and Preon Model #7

Particle	Number of preons	Preon structure	Particle properties*
Higgs- (e.g. rb’)	16	e.g. ABC’C’(CrC’g’C’b’)(CrCgC’b’)XXXXX and B’E(CrC’g’C’b’)(CrCgC’b’)XXXXXX	e.g. (0, 0, -0.5, red-antiblue)
Higgs+ (e.g. gr’)	16	e.g. A’B’CC(C’r’CgC’b’)(C’r’CgCb)XXXXX and BE’(C’r’CgC’b’)(C’r’CgCb)XXXXXX	e.g. (0, 0, 0.5, green-antired)
¼ G-	4	AAB’E’	(0, -2, -0.5)
¼ G+	4	A’A’BE	(0, 2, 0.5)
½ G-	8	AB’B’B’CCX or AAB’E’XX	(0, -2, -0.5)
½ G+	8	A’BBBC’C’X or A’A’BEXX	(0, 2, 0.5)
½ G2-	8	B’B’B’CCCCE’	(0, -2, 0.5)

½ G2+	8	BBBC'C'C'C'E	(0, 2, -0.5)
G- (e.g. br')	16	AB'B'B'CC(C'r'C'g'Cb)(C'r'CgCb)XXXX or AAB'E'(C'r'C'g'Cb)(C'r'CgCb)XXXXX	(0, -2, -0.5, br')
G+ (e.g. gr')	16	A'BBBC'C'(C'r'CgC'b')(C'r'CgCb)XXXX or A'A'BE(C'r'C'g'Cb)(C'r'CgCb)XXXXX	(0, 2, 0.5, gr')
G2- (e.g. bg')	16	B'B'B'CCCCE'(C'r'C'g'Cb)(CrC'g'Cb)XXX	(0, -2, 0.5, bg')
G2+ (e.g. rg')	16	BBBC'C'C'C'E(CrC'g'C'b')(CrC'g'Cb)XXX	(0, 2, -0.5, rg')
dark boson (e.g. br')	16	(C'r'C'g'Cb)(C'r'CgCb)XXXXXXX	(0, 0, 0, br')
Photon-	4	B'B'CC or AE'X	(0, -1, 0)
Z-	8	B'B'CCXX or AE'XXX	(0, -1, 0)
rg' gluon-	16	B'B'CC(CrC'g'C'b')(CrC'g'Cb)XXXXX or AE'(CrC'g'C'b')(CrC'g'Cb)XXXXXX	(0, -1, 0, rg')
Neutrino left	4	CE'X	(0, -0.5, 0.5)
Neutrino right	4	BC'X	(0, 0.5, 0)
Red up left quark	4	E'(CrC'g'C'b')X	(2/3, -0.5, 0.5, r)
Red up right quark	4	BC'C'(CrC'g'C'b')	(2/3, 0.5, 0, r)

*(electric charge, spin, weak isospin, colour)

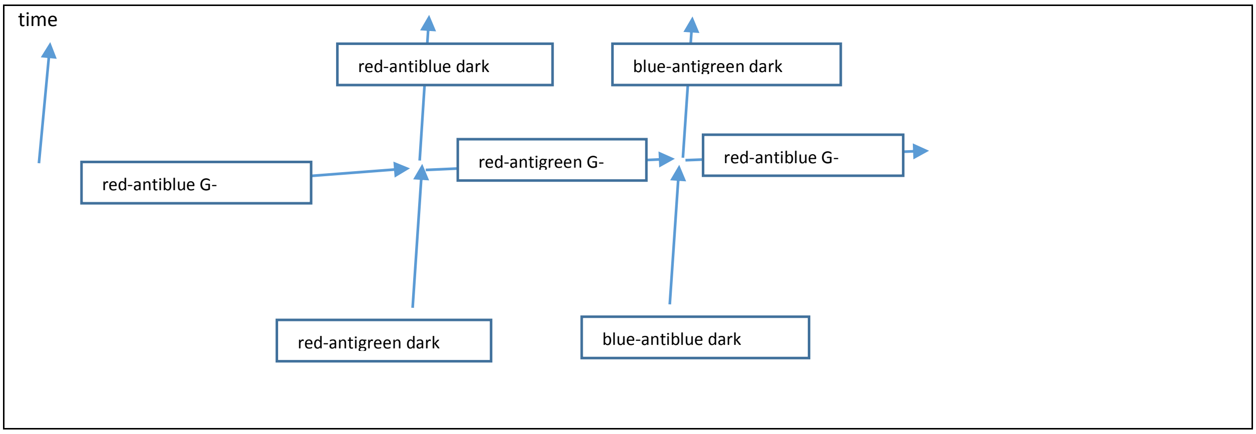
This paper is full of interaction equations of a pseudo-chemical style rather than using abstract mathematics. That is because the preon model is attempting to do for elementary particles what the periodical table did for molecules of chemicals. In chemistry, equations show how molecules are made of different combinations of atoms of elements. The atoms are conserved during chemical reactions. In this paper, elementary particles are like the molecules and the preons are like the atoms of the chemical elements. Unfortunately, the hexarks are more like the atoms in the periodic table than are preons in the following sense. If a hexark was omitted from the list of all 48 hexarks and antihexarks, it would immediately be noticed as a gap. The preons on the other hand are conjectures to try to give an appropriate aggregate of hexarks which attempts to minimise the number of different building blocks used in interactions. There appear to be far fewer than 48 building blocks required in interactions, but the number required is not certain. Preon D was introduced in May 2015 to cater for the up quark and the neutrino. A Preon E needed to be introduced, in a new Preon Model #7, to cater for the ¼ G graviton, which in model #6 cannot be built with as few as four preons.

Le Tho Hue and Le Duc Ninh (October 2015) presented a mathematical model, "*The Simplest 3-3-1 Model*", predicting electron-like particles with -1/2 charge and also particles with -1/6 electron charge. That mathematical model may prove very appropriate for preons or at least a good starting point for them. Preon A is basically a left-handed electron with charge -0.5. Preon C is the other half of the left-handed electron. Preon B is a right-handed electron with charge reduced to -0.5. Preon C is again the other half. When the now defunct preon D was devised, it did the job successfully for the up quark and neutrino, but it was not half of any particle, and it failed to succeed in constructing the ¼ G graviton. The new Preon E has been chosen deliberately to be a 'half', given artistic license, of a left-handed up quark, and it does allow the ¼ G to be constructed. Preon E is the antiup quark reduced in electric charge to -0.5 and stripped of colour. The up left quark has properties (2/3, -0.5, 0.5) and when stripped of colour and reduced to electric charge 0.5 leaves (0.5, -0.5, 0.5) which has been taken as Preon E'. So preon E has properties (-0.5, 0.5, -0.5) for (electric charge, spin, weak isospin). The other 'half' of the left up quark has electric charge +1/6 and colour red which is obtained from CrC'g'C'b'. So all the preons in Model #7 are effectively half electrons or half quarks with electric charge magnitude 0.5 or 1/6 coinciding very well indeed with the mathematical predictions of *The Simplest 3-3-1 Model*.

Dark matter

The candidate in this paper for dark matter is the particle with zero properties for electric charge, spin and weak isospin: the dark boson. There are three versions of this particle in Tables 1 and 2 and the ¼ dark and ½ dark do not have any properties being treated in this paper; it is not claimed that they can interact gravitationally, or even in any other way. The full dark boson with sixteen preons is complex enough in structure to support the property of colour-anticolour similar to the gluon, higgs and graviton in that generation. That property of colour would enable it to interact gravitationally with other dark bosons and also with quarks, gluons and higgs. Unlike other interactions in this paper, only colour is altered at every interaction involving a dark boson: not spin nor weak isospin. An example of two dark bosons interacting is shown in Figure Q.

Figure Q The exchange of a G- graviton between two dark matter bosons



For Figure Q, interaction 1 is:

Red-antigreen dark + red-antiblue graviton G- → red-antiblue dark + red-antigreen graviton G-

(0, 0, 0, rg') + (0, -2, -0.5, rb') → (0, 0, 0, rb') + (0,-2, -0.5, rg')

[CrC'g'C'b'][CrC'g'Cb]XXXXXXX + AB'B'CC[CrC'g'C'b'][CrCgC'b']XXXX →

[CrC'g'C'b'][CrCgC'b']XXXXXXX + AB'B'CC[CrC'g'C'b'][CrC'g'Cb]XXXX

For Figure E, interaction 2 is:

Blue-antiblue dark + red-antigreen graviton G- → blue-antigreen dark + red-antiblue graviton G-

(0, 0, 0, bb’) + (0, -2, -0.5, rg’) → (0, 0, 0, bg’) + (0,-2, -0.5, rb’)

[C’r’C’g’Cb][CrCgC’b’]XXXXXXX + AB’B’B’CC[CrC’g’C’b’][CrC’g’Cb]XXXX →

[C’r’C’g’Cb][CrC’g’Cb]XXXXXXX + AB’B’B’CC[CrC’g’C’b’][CrCgC’b’]XXXX

Preons are conserved in interactions 1 and 2.

The red-antiblue graviton G- is the incoming and outgoing boson catalyst for the graviton exchange while the red-antigreen graviton G- is exchanged between the two dark bosons. All participants in the interaction change colour but retain spin and weak isospin handedness.

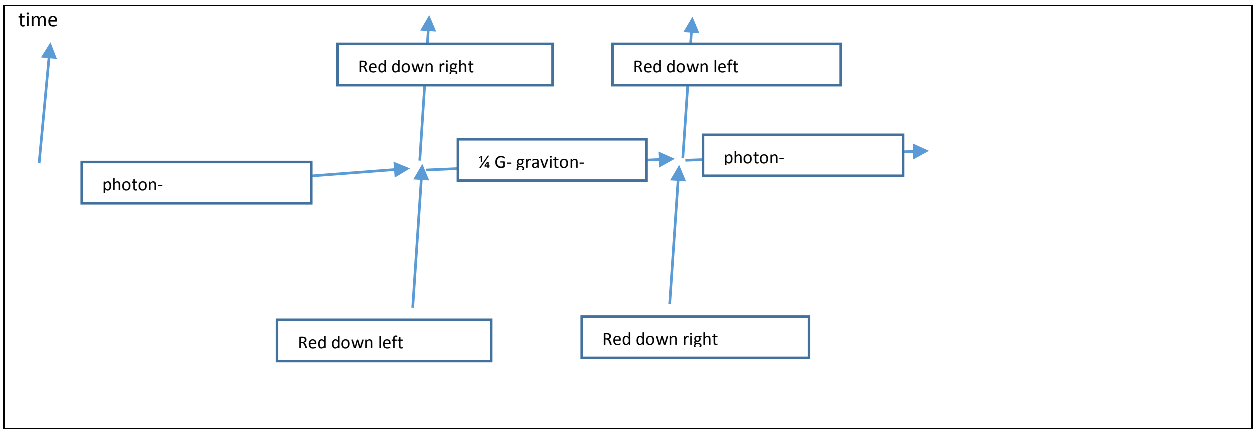
It is maybe ironic that the only property of dark matter is colour.

The higgs could also be a dark matter boson (see Figure N).

Dark energy

Dark energy is implemented via the ¼ G graviton as seen in an example in in Figure R.

Figure R The exchange of a ¼ G- graviton between two red down quarks



For Figure R, interaction 1 is:

Red down left + photon- → red down right + 1/ 4 G- graviton

(-1/3, -0.5, -0.5, r) + (0, -1, 0) → (-1/3, 0.5, 0) + (0,-2, -0.5)

A[CrC’g’C’b’]X + AE’X → B[CrC’g’C’b’]X + AAB’E’

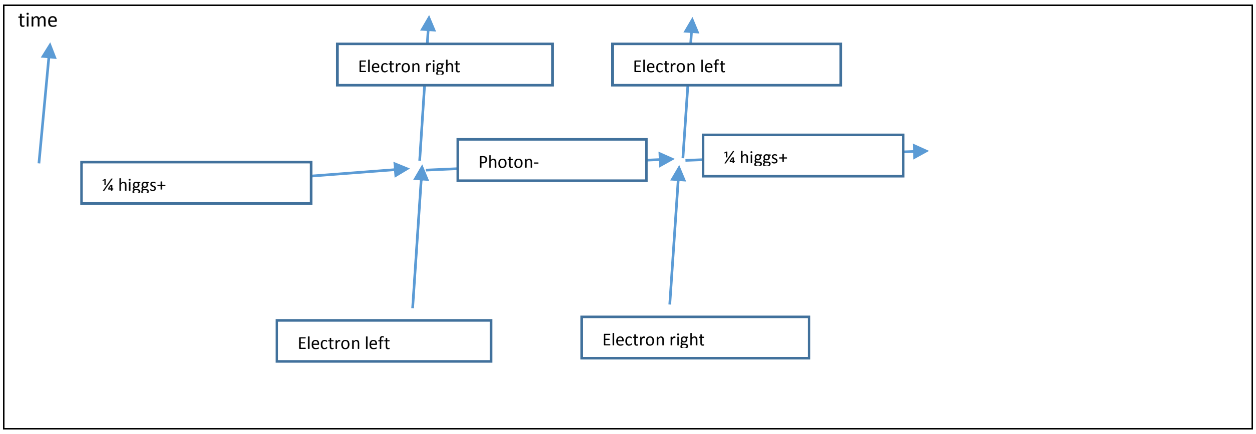
For Figure R, interaction 2 is the reverse of Interaction 1.

The photon- is the incoming and outgoing boson catalyst for the graviton exchange while the ¼ G-graviton- is exchanged between the two red quarks. This first generation gravitational repulsion is masked by a stronger third generation gravitational attraction (between opposite colour quarks) unless the quarks are extremely far apart on a galactic scale. Because the ¼ G is colour-blind the force between all quarks depends only on their electric charge which is predominantly positive charge for quarks and hence predominantly repulsive.

A very similar diagram to figure R could show the gravitational repulsion of two electrons, using the photon as catalyst boson.

Figure S shows the ordinary EM repulsion between two electrons.

Figure S The electromagnetic exchange of a photon- between two electrons



For Figure S, interaction 1 is:

Left electron + ¼ Higgs+ → right electron + photon-

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

ACX + A'B'CC → BCX + B'B'CC

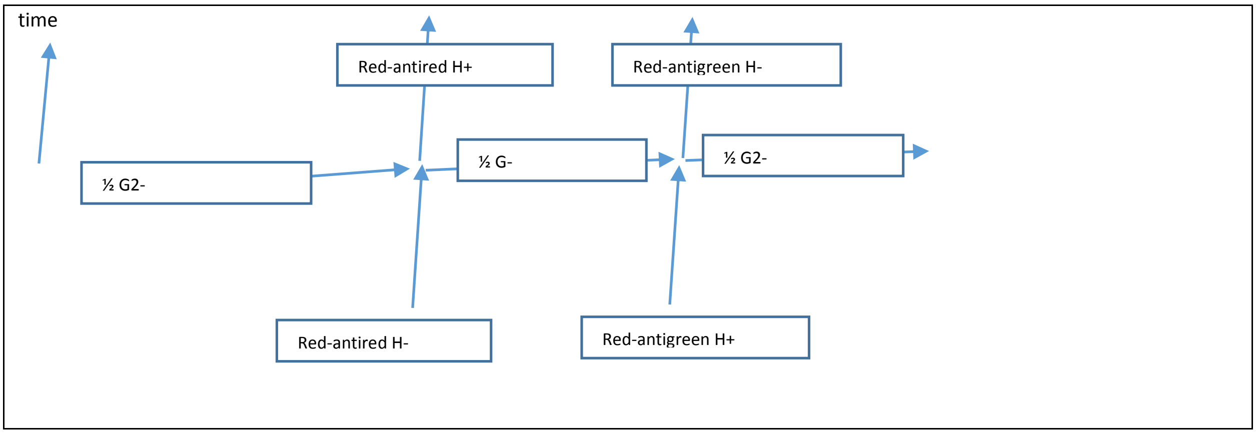
where the incoming X is BB' and the outgoing X is AA'. Note that restrictions on values of X could be important in determining the likelihood of an interaction occurring. For example. The above interaction could not happen with every pair of electrons, for example, it could not happen if the two electrons were AC(AA') and BC(AA').

For Figure S, interaction 2 is the reverse of Interaction 1.

The ¼ Higgs+ is the incoming and outgoing boson catalyst for the photon- exchange between two electrons.

The higgs, because it has weak isospin 0.5, can interact with the ½ G and hence effect a repulsion (Figure T) at large distances away from the dominance of the third generation graviton. So the higgs can play a role in dark energy. The dark boson which has no spin or weak isospin cannot take part in dark energy.

Figure T The exchange of a ½ G- graviton between two Higgs bosons



For Figure T, interaction 1 is:

Red-antired higgs-   +   ¼ G2-   → red-antired higgs+ + ½ G-

(0, 0, -0.5, rr') + (0, -2, 0.5)   → (0, 0, 0.5, rg') + (0,-2, -0.5)

ABC'C'(CrC'g'C'b')(C'r'CgCb)X + B'B'B'CCCCE' → BE'(CrC'g'C'b')(C'r'CgCb)XX + AB'B'B'CCX

Although a ¼ G preon structure has been found, a ¼ G2 preon structure cannot be found using preon model #7. Such a structure would have let the higgs take part as dark energy with a first generation graviton as well as the second generation graviton.

Summary

Points presented in this paper are itemised below.

(a) A revised model (#7) for preon structures has been constructed to cater for gravitons. This involved removing the old preon D and inserting a new preon, Preon E.
(b) Many particle interactions are detailed, and illustrated in Figures B to T, for the exchange of force bosons, including the graviton, between a wide range of pairs of particles.
(c) Gauge boson exchange between particles is implemented with the help of catalyst bosons. Normally the outgoing catalyst boson is identical to the incoming catalyst boson. (Figure A)
(d) Normal gravitational attraction between atomic nuclei is carried out via third generation colour-anticolour gravitons, G- with spin -2, between quarks of different colours. One form (G-) has weak isospin -0.5 while a second form (G2-) has weak isospin 0.5. All spin signs can be reversed to obtain the G+ and G2+ gravitons. This is Gravitational QCD.
(e) Gravitational repulsion at a vast difference is responsible for dark energy and is implemented by the first generation ¼ G- and ¼ G+ gravitons. This is Gravitational QED. For particles less remote from one another, the repulsive effect of ¼ G between like-colour quarks is masked by the much stronger attractive effect of G between unlike-colour quarks in Gravitational QCD.
(f) There is a ½ G- graviton (and ½ G+) which parallels, in terms of gravity, the role of the Z boson for weak force in the Standard Model.

(g) Electrons gravitationally repel other electrons in this model.

(h) Dark matter is the dark boson which has no known properties for a first and second generation boson, but has colour-anticolour in the third generation dark boson. Its interactions involve change of colour in all particles involved but none of the participants change spin or weak isospin or electric charge. The higgs boson is also a candidate for dark matter. The dark boson is subject to the attractive Gravitational QCD but cannot take part in the Gravitational QED or Gravitational Weak and so cannot contribute to dark energy. The higgs can contribute to dark matter attraction and dark energy.

(i) The third generation gluons are already known to have colour-anticolour. The higgs is also a third generation boson and also has colour-anticolour in this model.

(j) In this model, the photon, Z and gluon are first, second and third generations, respectively, of the same single family of bosons. The W has been placed into its own family which possibly has ½ W and 2W as members. All elementary particles now fit into a simple table of generation Columns by family Rows.

(k) A paper by Le Tho Hue and Le Duc Ninh (October 2015) may provide a mathematical model appropriate for the Hexark and Preon Model #7 or perhaps a good starting point for the appropriate mathematical model.

References

Fearnley, A.J. (May 2015) "*Hexark and Preon Model #6*". vixra.org/abs/1505.0076

Le Tho Hue, Le Duc Ninh (October 2015) "*The simplest 3-3-1 model*". arXiv:1510.00302 [hep-ph]

20 October 2015

Manchester

England