Hexark and Preon Model #8 and the unification of forces: a summary

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Abstract

This paper summarises a model for building all elementary particles of the Standard Model plus the higgs, dark matter, dark energy and gravitons, out of preons and sub-preons. The preons are themselves built from string-like hexarks each with chiral values for the fundamental properties of elementary particles. The four forces are shown to be unified by hexarks being string-like objects comprising a compactified multiverse-like structure of at least 10^39 strands of string-like 4D space and time blocks (septarks). Despite the individual forces seeming very different from each another, they all derive from the same colour strands, either as net colour braids (QCD and attractive gravity) or as net neutral-colour braids/strands (electric charge, weak isospin and dark energy, or repulsive gravity). Different strength forces have different numbers of braids in them but QCD-colour is qualitatively, but not quantitatively, the same as gravitational colour while electric charge, weak isospin and dark energy are all qualitatively the same neutral-colour mix, but not quantitatively the same.

Summary of unification

Preon Model#8 unifies all four forces of the Standard Model. Model#8 is a non-mathematical, naive model for building elementary particles: as in using lego or meccano component pieces, but its fundamental pieces (hexarks and preons) are many-dimensional so it is not a simple build. Model#7 starts with hexarks as the smallest sub-particles and builds up from there. Despite being sub-particles, hexarks have the notion of dimensions integrated into them. For example, the red QCD property needed to be held by some hexarks and so it was built into them as a fundamental part of them. Even at the Big Bang, all the hexarks already existed, and in them were contained all the necessary dimensions for their futures. It is suggested that entering at the Big Bang, or a node in Penrose's Cyclical Conformal Cosmology (CCC), the hexarks retained their structure within preons. Preons are a fifth-order layer of structure whereas hexarks are a sixth-order layer: quarks, say, being the fourth-order stratum of particles. Entering the CCC node, all the hexarks were in preons, and all the preons were necessarily in bosons, say, photons, which can all occupy a single state as a condensate. In Model#8, an aggregation of many individual hexarks is held together by a new very strong force, and for this very strong force there is a very strong force carrier, say the hexon, between the hexarks. It takes at least 48 hexarks to make a preon but only four preons to make an

electron or photon. QED and QCD are sufficient to hold together the preons, but not sufficient to hold together the hexarks. Entering the CCC node, or Big Bang, all the forces might be retained until the point at which the condensate occupies a single state. At that point the metric of space and time is lost and all the four forces merge into one force. For this merging to occur there must be some communality between the four forces that has always existed. This implies that there is some communality between the hexons, the gluons, the photons, the gravitons, and the W and Z which are the weak force carriers. And the Higgs particle and field.

For Model#8, using a strand of fibre optics as an analogy, everything is built up from a 4D strand which sits at the seventh layer of particle (septarks). A fibre optic strand has 4D of space and time, but also has a direction of travel for the light shining along it. Although QCD red, green and blue are not truly the same as electromagnetic light it is useful to keep that analogy. However, all that is needed for our strand is that it have four dimensions and a direction of time for it. Similar to our universe having apparently four dimensions with a sense of a direction of the passage of time. The red, green and blue are qualities which themselves may need unification and that could be done by having the three 'colours' being each a different set of 4D. So all we need are three very similar strands but each occupying a different 4D making 12D in total, with the colour merely being a label to specify which particular set of 4D is occupied. A further strand with a further set of 4D is required for our space and time dimensions along with a sense of direction of the flow of time within it. The 12 colour dimensions (forming three colour branes) are presumed to be compactified in the sense used in string theory so that there are 4 full-sized space/time dimensions and 12 compactified, microscopic colour dimensions. There is no qualitative difference between a full-sized dimension and a compactified one. It is possible that what is now the red dimension, may have gone into the Big Bang as a full-sized 4D of space and time. And our current space and time may previously have been used as the red dimension. This is similar to space and time possibly inverting dimensions from outside to inside a Black Hole.

Next we need to consider how to provide the three, compactified sets of colour dimensions with a group structure, which is achieve through braiding. Coloured light has long been used to illustrate the relationship between QCD quarks and gluons. In particular, red holds in it some element of blue and green. Ditto for the other two colours in turn. Also red + green + blue is neutral in colour. Further, red, green and blue light have opposites or anticolours as cyan, magenta and yellow, respectively. Adding colour to anticolour light makes white, so red + antired = red + cyan = white and moreover cyan = green + blue. All these light relationships apply in some way to QCD colours and are an essential part of QCD's group relationships. More on this later in the report.

For the forces to be capable of unification, there must be some similarity between the colours of QCD, gravity, QED and the weak force and the colours in the new hexon. In Model#8 the label 'colour' merely identifies which different set of 4D is being used and therefore the same

sets of dimensions must be being used in all the forces. That is, the same 'colours' must apply across all forces. As the four forces vary in strength the quantity of colour must vary according to the force. Returning to the analogy of strands of fibre optics, the number of strands involved must be smallest for gravitation and largest for the new hexon, with QCD in between. All the forces must be caused by varying numbers and combinations of (pseudo) fibre optic strands (or septarks) and this allows a unification of all the forces as one goes back in time to the Big Bang.

This unification means that QED, the weak force and gravity must all have a 'colour' ingredient within them. Taking QED first, my preon models have long used the connection that the QCD colour of a hexark also directly determines its electric charge (Fearnley, November 2015). Similarly the colour of sub-preons Cr, Cg and Cb, determines completely their electric charge. This, at first thought, seems to be at odds with the fact that a red quark can be a positively charged (up quark) or a negative (down quark). However. In model#7 a left-handed up quark is the following aggregate of preons: E' Cr C'g' C'b' C C' while a left-handed down quark is: A C'g' Cr C'b' C C' where A and C are colour-neutral preons while E' and C' are colour-neutral antipreons. Both the up and down quarks get their redness directly from the red Cr and indirectly from C'g' and C'b' which are red, antigreen and antiblue, respectively. What makes the up quark net positively charged is the inclusion of the positively-charged antipreon E' in its structure, and the down quark is made negative by the inclusion in its structure of the negatively-charged preon A. Preon A is composed of negatively charged red, green and blue hexarks while Preon E' is composed of positively charged antired, antigreen and antiblue hexarks. This argument allows electric charge to be directly caused by QCD colour at the level of hexarks, preons and septarks of (pseudo) strands of colour fibre underlying all the forces: but there is no direct relationship between QCD-colour and electrical charge at the level of elementary particles and this latter point confounds an understanding of the direct relationship which lies at the heart of the unification of forces.

Next, how do the varying strengths of forces arise? Suppose our full-sized 3D space be represented by a 2D plane. Let a 4D red strand move at random into, and out of this 2D sheet in an immensely long random walk so that the 2D plane is touched or crossed by the strand a staggeringly large number of times. As the red 4D's time direction is unrelated to our time direction, in the 2D plane, the red strand can travel from point A on the 2D plane and reappear at point B in the 2D plane in our past. As the red strand is not limited in its travel by our time dimension, it can criss-cross at point A as often as it likes. The 4D red strand can fill and overlay the 2D plane multiple times and in any time order. A red strand travelling in our time direction would be labelled 'red' but a red strand travelling against our time direction would be termed 'antired'. This is the same as for coloured and anti-coloured quarks and gluons on a Feynman diagram. But how many (septark) strands are needed to comprise the QCD-red colour in a hexark?

As QCD-red and gravi-red are made of the same red strands there could be about 10^39 times more strands in QCD than for gravitation. But, first, it was started but not completed above how to introduce the colour group structure and that should be shown now. The (pure) red, green and blue colour strands used as starting objects for unified forces are completely independent and have no useful group structure. A group structure could, however, be forced by braiding/ plaiting or simply grouping and binding strands together as in an optical cable. Take three independent colour strands red, green and blue which do not have a group structure. Then braid them so that you have a red + antigreen + antiblue braid, and ditto for a green + antiblue + antired braid and thirdly, a blue + antired + antigreen braid. Then these three unpure braids are RED, GREEN and BLUE such that adding the RED and GREEN gives net antiblue while adding RED + GREEN + BLUE gives colour neutrality, just as in adding QCD colours. Colour neutrality does not imply complete zero as RED + GREEN + BLUE makes WHITE which has negative electric charge at this level of particle. That implies a negative QED charge or negative gravi-charge or negative hexa-charge. Note that ANTIRED + ANTIGREEN + ANTIBLUE aggregates to BLACK which is positively charged. It is hard to imagine black light, but one can envisage adding cyan + magenta + yellow oil paints to get black paint, or more simply refer to black as anti-white.

So the gravity force needs at least three unpure colour braids comprising nine pure colour strands, though of course there could be much more braiding especially as QCD force is going to need many more braids. If the braids are themselves braided in turn in a sequence of layers then there could need to be approximately 82 levels of braiding to make 3^82 = 10^39 approximately, which is how much, at the scale of quarks, that QCD is stronger than gravity.

Assuming that we can now envisage a system of cables of braids representing the forces, QCD is represented by cables containing a (vast array) of colour strands which have a net colour or anticolour. QED is represented by a similar-sized cable which has a net white (negative electrical charge) or net black (positive electrical charge) colour. QED gets its white colour from a tailor-made white or black cable whereas the weak force could maybe get its whiteness/blackness from a combination of colours in the QCD cable. Call this a third cable labelled the 'weak isospin' cable strapped to the main QCD cable.

Another analogy is to take a 2x2x2 Rubic cube designed with six colours: red, green and blue and their three anticolours. All eight sub-cubes are vertex cubes. Adding up the three colours/anticolours on their faces leads to three colour sub-cubes, three anticolour sub-cubes, a white sub-cube and a black sub-cube. So the six colour/anticolour sub-cubes contribute to QCD while the white and black sub-cubes form the QED charge. Weak isospin dimensions could arise from further combinations of QCD colours that happen to make white or black.

An interesting feature of this colour model is that the unified forces do all look structurally the same and there is a fractal-like pattern in the main braids, or cables of braids, gradually splitting off or fraying over time. Just as the white/black QCD dimensions are separated (as

weak isospin) from the QCD colour dimensions then it is likely that the gravi-colours also became separated from the gravi-black and white dimensions. The gravi-white could be to gravi-colour as negative electric charge of QED is to QCD colour. That is, just as QCD quarks attract close up within the nucleus and electric charge attracts or repels outside the nuclei, then gravi-colour might attract nuclei on an intergalactic scale but gravi-white/black might repel nuclei at an even vaster distance beyond the reach of gravi-colour and is a candidate for the source of dark energy. Similarly, the concept of the 'weak' forces may somehow apply to give a gravitational-weak force as a result of the separation of gravi-colour dimensions from gravi-black and white dimensions. Likewise the hexa-charge very strong force, if it exists, can have a coloured component and a black and white component and the concept of a 'weak' very strong force might apply here too.

The completely unified force dimensions are represented by a single, huge and homogeneous cable of (unpure and hence with a group structure) coloured and anticoloured braids of pure colour strands. This cable forks into two unequal pieces, a massive cable for the hypothesised very strong hexa-charge and a smaller cable for the remainder. The remainder fork splits into a very small gravitation cable, with an imbalance of colour, and another remainder cable. This remainder cable splits into the QCD charge cable and the QED cable. Each cable is comprised of the same type of assembly of colour strands but the QED cable is net white or net black while the QCD cable(s) has(have) imbalances of colours. A further (weak isospin) cable splits off the QCD cable and contains white and black assemblages of strands obtained direct from the QCD colours. It is known that weak isospin contributes to electric charge but can be nullified by weak hypercharge. The Higgs particle has weak isospin but no electric charge and can fit into this model. The left-handed electron in my model has weak isospin inserted as a fundamental quality, and weak isospin is seen in my unified model to contain electric charge, but the electron's total negative charge, in my naïve model, comes only from QED (which in my model is QCD-colour-neutral braids). This shows the need for the Higgs as a field to vary the QED and weak isospin strengths in the left-handed electron to conserve the electron's net electric charge at -1. That is, without causing the electron to have an interaction which entails a collapse of its field.

The Preon Model early versions arose from a building of 'concrete' particles. There is, of course, a wave-particle duality of field effects and particle effects and eventually the hexarks' fundamental qualities took on the appearance, at least in my thoughts, of separate dimensions of 4D blocks of space + time. Model#7 (Fearnley, November 2015) has 24 hexarks and 24 anti-hexarks where each hexark has one, and only one QCD-colour or anticolour. Higher generations of elementary particles are built from more preons per particle than lower generations. The first generation QED particles do not have enough preons in them to make net coloured particles. However, they must contain net gravi-colour to allow them to participate in the generally attractive gravitational force. To do this each hexark is re-designed in Model#8 to include three qualities of gravi-colour which now allows all elementary particles to have gravi-colour. But whereas the single QCD-colour quality in a

hexark contains about an '82-fold-upon-fold' braid of colour, or about 10^{82} pure strands or septarks, the three gravi-colours in the same hexark each contain a minimum of a mere three braids, or at least nine pure strands. These numbers are designed in proportion only, and both could be, and probably are, much greater. The photon and gluon, re-designed to include gravi-colour, could each be the gravitons, still retaining spin 1. As mass has not been written into Model#8 as a gravitational charge, where gravi-colour is used instead, there is no need for the graviton to have spin 2. Spin 2 was required to exert an attraction between two like-sign mass charges, as spin 1 would repel them. But eschewing mass as charge removes the need for spin 2. Gravitation is predominantly attractive in the same way that QCD is predominantly attractive. QCD acts over a small range but gravitational attraction will spread its net over a space 10^{39} times further away than QCD. Gravitational repulsion will come in two ways. First, in pure white and black QED-like gravitational charges at a great distance, beyond the scope of gravitational gravi-colour attraction, giving rise to dark energy. Second, even at close range there will be some gravitational repulsion between like gravi-colours. It is unlikely that this will be detected anytime soon as the QCD-red quark is difficult and maybe impossible to isolate in order to experiment on and anyway is likely not to be gravi-red as QCD-colours and gravi-colours are independent of each other (that is, in statistical terms, their QCD and gravitational colours are crossed, not nested). Likewise, most electrons will gravitationally attract one another, as their gravi-colours will be different, but a smaller number of like-gravi-colour interactions of electrons will occur and will be repulsive.

Lisi's excellent and beautiful E8 model (Lisi, 2007 and 2010) for elementary particle construction has some points of comparison with my naïve model#8. First, Lisi uses group theory mathematics to put elementary particles in an E8 group relationship to one another as members of the closed group. My naïve model simply uses braided strands to arrive at a group structure for colour. Lisi includes gravitation in the E8 model but his gravitation model does not appear (to me) to have net colour gravitons. Whereas Lisi moves direct to elementary particles as members of E8, my model moves direct to hexarks as having the group colour relationships, and then my model uses aggregates of hexarks to make preons and then aggregates of preons to make elementary particles. Lisi notes that there is room within E8 for a few more undiscovered elementary particles in which he predicts some coloured particles in the higgs family. My preon model#8 also contains coloured elementary higgs particles, and coloured dark matter elementary particles. Lisi does not see string theory as connecting with his E8 model and yet my hexarks seem to me to be strings. I have a model of an electron being composed of hexarks with one closed end of each hexark being on a coloured brane, and the open ends of the hexarks being attracted to one another across branes (using a new very strong force enforced by hexons). The branes rotate around one another like a revolving triple helix similar to a Hopf fibration. In my model, though, there is no such thing as a pure colour brane as all my branes are multi-coloured with anti-colours included. Finally, Lisi puts three families or generations of particles into a closed group structure whereas in my model the number of families is open and not restricted to three.

Higher generations in my model are more complex, via containing more preons, than lower generations. This allows the photon, Z and gluon to be viewed as three generations of gauge bosons, in increasing order of complexity where only the highest level can contain net QCD-colour plus anticolour properties.

A particle/field is for most of its lifetime a field which only briefly becomes a particle at interactions. Viewing the hexark as having colour dimensions populated by septarks makes it seem more like a field model. And the requirement for QCD-red to have a time arrow representing the direction of flow of the red light brings me to imagine the QCD-red dimension as a compactified version of our space plus time with a time's arrow. The unification is based on four blocks of space & time in 16 dimensions simultaneously. It does also require an amazing numbers of strands (septarks) of these space & time 4D blocks, some 10^{39} of them for QCD and maybe another 10^{80} of them for hexa-charge. It seems like a scenario for the use of compactified multiverses.

A further paper will follow showing more structural details of Model#8 with respect to preon structures of gluons, gravitons and so on.

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