The Spin Of The 'Boundary Chord' Nucleus And The Inference Of Charge†

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Abstract

With a proton and neutron comprised entirely of ***boundary chords***, (which are themselves the result of a *dimensional differentiation* within an earlier evolutionary phase of our universe), the resultant geometry will create a total of seven *rotational groups* that will provide these bodies with their mass, spin and component of ***charge***. These groups will be of two distinct types and number and it will be these differences that provide the proton especially, with its observed *dual* component of electronic potential. It will be shown that the forced evolution of the *Stage 1* teddy (or neutron) due to spin-conflict within its structure, will necessitate a further (*Stage* 2) reconfiguration which, because of the need to conserve existing angular momentum, will provide these *rotational groups* with different but measurable angular velocities of rotation – and this in turn, will produce two *opposite* components of charge. Not only will these components have positive and negative characteristics, but their magnitude will also be as a direct result of the proton's geometry. It will also be shown that the proton's (Coulomb) charge and its resultant face surface areas have in this model at least, a direct and binding relationship to the accepted value of the *permittivity of free space*, which now becomes an integral part of the proton's description.

1.0 Introduction

It was argued in the previous paper (*Tregellen [1], July 2007*), that the resultant configuration of the teddy's faces *already* provides *ALL* of the necessary characteristics that will naturally allow charge to occur - and this paper will attempt to illustrate this further. It will also attempt to show (almost coincidentally), that these faces and their imposed *face-spin bias* are the reason *WHY* the proton appears to display two *different* kinds of charges in the first place, which have formerly been assigned to the existence of those sub-atomic particles – the 'quarks'. Although very real as far as this model is concerned, these separate components of charge (the positive and negative that would appear to result in the elemental), *DO NOT* now require the concept of these quarks as a descriptive part of the proton and neutron. The whole surviving teddy that *pinged* into what would become our 3D part of the universe, has all the necessary attributes already, once its two-stage reconfiguration is accepted.

The imposed charge exhibited by the *Stage 2* reconfigured teddy (or what can now be called the *proton*), will have everything to do with its ***spin ratios***. Although these have already been defined in the previous paper, they are an important concept in their own right and will be reiterated upon here. This is basically the difference between the overall surface areas of the hex and square faces (all of which are now circular after the *Stage 2* reconfiguration). This ratio amounts to:

$$\frac{\textit{Total square}\quad 4.712 \times 10^{-28}\ cm^2}{\textit{Total hex}\quad 1.884 \times 10^{-27}\ cm^2} = \mathbf{0.25}$$

The total 'H' face area is obviously the larger of the two and could be deemed to reflect the

† Conclusions drawn from *'The Boundary Chord Model'*

positive component of charge - which up until now - has usually been associated with the proton's two 'up' quarks. If the *FOUR* 'H' face pairs are allowed to produce a charge of $+{}^{1}/_{3}$ each, the total 'H' face charge in this model will correspond to the required $+{}^{4}/_{3}$ previously contributed by these two ghostly sub-atomic particles. Using the *spin ratio* of *0.25*, this allows the three 'S' face pairs an overall (counter) charge of:

$$1.33 \text{ (or } {}^{4}/_{3}\text{) } (\uparrow\uparrow) \; x \; 0.25 \; = \; \mathbf{0.33} \text{ (or } {}^{1}/_{3}\text{) } (\downarrow)$$

The problem at the moment is that this 'S' face component of charge needs to be *negative*. This *IS* achievable however, if one takes into account the rotation of the *de-gassed* 2D membranes (of both 'H' and 'S' faces) – and the consequential effects brought on by the necessary conservation of angular momentum. It may have already been noticed that the terms *'H' face* and *'S' face* are still being used - even though the teddy's reconfiguration has left both types as circular varieties. This will continue as this provides both a logical link to the origin of these planes *and* is still the best way of differentiating between these two different sizes. The 'H' face is the larger and more numerous, with four pairs – or a total of eight.

Returning to the problem of this negativity, the key to *how* this can be achieved, lies firmly with these 2D membranes - that de-gas from the boundary chord material that forms the circumference of each of the teddy's faces. The proton becomes such *not* just because of charge, but also because of the apparent three-dimensional mass loss used by these membranes – again, during *Stage 2* reconfiguration. It is these membranes that also provide the solution to the problem of *spin-conflict* caused by the inherent *face-spin bias* - carried over from the initial *big-snap* that separated whole surviving teddies and independent boundary chords out from the 8D lattice. The neutron (or a pre-*Stage 2* teddy), has this *spin-conflict* within its structure and this comes about as its *face-spin bias* is transferred and therefore imposed upon each of the (six) 'S' faces by their four neighbouring (and now rotating) 'H' face *boundary chord values* that now surround them. It is *this* conflict, which helps bring about the *Stage 2* reconfiguration in the first place (see *Figure 1.01* below).

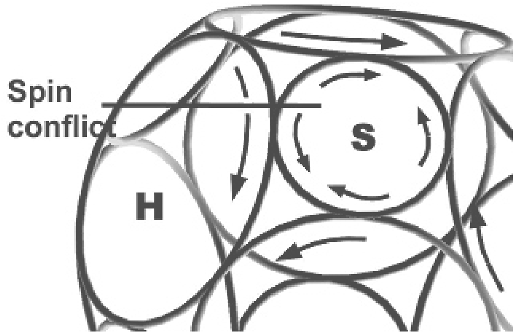

Figure 1.0.1 *The reconfiguration of the teddy occurs because of a spin conflict within the imposed face-spin bias components of its individual faces. This will later be solved as the spin is transferred to its 2D membranes.*

As the de-gassing of the teddy's 2D membranes occur, this *face-spin bias* is again transferred, causing these membranes to rotate *instead* of the induced spin (or potential) trapped within the boundary chords. The 'H' face membranes will retain the spin direction originally exhibited by the 'H' face chords; while the 'S' face membranes will actually be seen to have a choice. As it is the membranes that have now inherited the *face-spin bias* and *NOT* the adjoining chords, their rotation is now isolated from that of all other adjacent membranes. The *spin conflict* will disappear and each of the six 'S' faces can be allowed to rotate either clockwise or counter-clockwise – resulting in a fifty-fifty chance as to just which rotational direction this actually becomes.

Due to the configuration (and of course, reconfiguration) of the teddy in the first place; (where rotation of its boundary chords because of *face-spin bias* ends up almost 'cog-like'); the 'H' faces will tend to rotate as pairs anyway and in order to conserve equilibrium, the 'S' faces will tend to follow suit. This means that whatever the choice of rotation in one 'S' face membrane, the other member of the pair will result in being of the *opposite* (or what will be referred to as *complimentary*) rotational direction.

As already hinted at above, the original *face-spin bias* carried over from the *big-snap* can be thought of as being more akin to a potential – as it would be the *tendency* for the boundary chords to rotate about the axis *normal* to any particular face. There would quite naturally be a relationship between the surface area of these membranes and therefore, the circumference of the face itself. As each component of *face-spin bias* is transferred to its corresponding 2D membrane, this potential will translate into rotational energy and it would thus be possible to assign this rotational component a definitive value.

2.0 Membrane Rotation

The easiest way of illustrating this phenomenon in the first instance, may perhaps best be achieved by looking at what is basically the 2D membrane's ***moment of inertia*** (*I*). The apparent 3D *mass equivalence* of the 'H' face membrane can be calculated from the resultant *Stage 1* boundary chord mass (M^{bc}), where the 'H' face chord mass 2D equivalence:

$$6 \text{ x } \frac{M^{bc}}{10^{3}} \quad \text{or}$$

$$6 \text{ x } \frac{2.325 \text{ x } 10^{-29} \text{ kg}}{10^{3}}$$

$$= \mathbf{1.395 \text{ x } 10^{-31} \text{ kg}}$$

where '10^{3}' is the appropriate '1D' conversion factor – which will be the same for both types of faces. The above value becomes the 'H' face 2D membrane's ***3D mass equivalence***. As these membranes can in this example, be considered simply as rotating disks contained within the circular boundary of its parent 'H' face, their *moment of inertia* can be gleaned from the conventional expression:

$$I = \tfrac{1}{2}Mr^{2}$$

where the radius of the face in this instance, has already been calculated at $8.660 \text{ x } 10^{-15}$ *cm*. Thus, the *moment of inertia* of each 'H' face 2D membrane becomes:

$$\frac{1.395 \text{ x } 10^{-31} \text{ kg}}{2} \text{ x } (8.66 \text{ x } 10^{-17} \text{ m})^{2}$$

$$\text{Therefore, } \mathbf{I^{H} = 5.23 \text{ x } 10^{-64} \text{ kg m}^{2}}$$

Similarly, the *moment of inertia* of the teddy's 'S' faces can also be calculated through similar methods, because the resultant masses of the 'S' face membranes are also known within this model. Therefore, the total 3D *mass equivalence* of these particular 'S' face 2D membranes will have a value that equates to circa $9.300 \text{ x } 10^{-32}$ *kg* together with a corresponding radius of $5.000 \text{ x } 10^{-15}$ *cms* (remembering that these are the smaller of the two types of membrane).

In this instance, the 'S' face membrane *moment of inertia* will in turn be equivalent to:

$$\frac{9.30 \text{ x } 10^{-32} \text{ kg}}{2} \text{ x } (5.00 \text{ x } 10^{-17} \text{ m})^{2}$$

$$\text{and so for the 'S' face: } \mathbf{I^{S} = 1.16 \text{ x } 10^{-64} \text{ kg m}^{2}}$$

As it is 'rotational symmetry' that gives rise to angular momentum and its conservation - it is the transfer of *face-spin bias* to the teddy's 2D membranes that results in an angular momentum about the membrane's center of mass. This is all very well with a simple 'single' spin axis , but in this case - the angular momentum of a 'massive' particle like the teddy, will actually comprise four 'H' pair and three 'S' pair components. This means that the teddy (in reality) contains a total of seven ***rotational groups*** and each of these groups will occupy a specific axis location or ***axis coordinate***, which will be the same as the teddy's constant motion axes – (defined in a later paper). Each *rotational group* therefore comprises two, 2D membranes with complimentary-rotating components, which produce a paired system with a combined angular momentum. These may (but certainly not yet) be equivalent or comparable to the *Lie Algebra* of rotational groups such as O(3) or SO(3) – but this work has a long way to go before such comparisons can be properly made. The resemblance of these 'paired' rotational components to *Pauli matrices* is also a possibility and this too will be explored at a somewhat later date.

Before the effects of this angular momentum can be discussed more fully, the rotational characteristics of these 2D membranes need to be examined in a little more detail. It is also possible that this rotational aspect of the teddy can be described as a *wave function* and the value of these components could be referred to as *spinors* or ***spinorial objects***[1] and as such, the original *face-spin bias* of any particular 'H' face, must allow itself the ability of being described in terms of *multiples* of – or indeed *divisibles* of, a full 360° or $\boldsymbol{2\pi}$ rotation. In other words, and for this purpose, it would be handy if these 2D membranes could be provided with a value that corresponds to their ***angular velocity of rotation*** (ω). At this moment in time, such a value for the original *face-spin bias* component would be pure conjecture *but* - this is not important for an understanding of just how this concept of charge may work within the body of the proton (or *Stage 2* reconfigured teddy). What is important is the relationship that can be afforded these 'H' and 'S' face membranes in terms of the *production* of elemental charge. In this respect, this 'H' face membrane's *angular velocity of rotation* (ω) can be given any value one wishes for the time being - as long at it can also be shown that the corresponding 'S' face membrane's own *angular velocity of rotation* bears a direct and calculable relationship to it.

Therefore, for this exercise – and considering the character of the 'H' face to begin with – the *angular velocity of rotation* (ω) of 'one-sixth' an 'H' face circumference (one boundary chord), can be given the basic value of ***1.047 rad.*** $\boldsymbol{s^{-1}}$ (based on an overall 'H' face rotation of 2π or *6.283* rad. s^{-1} divided by six); which will have the advantage of providing the simplest of approaches to this question of comparison. This will also allow the ***angular momentum*** (L) to be calculated for each of these 'H' face 2D membranes; where:

$$\text{angular momentum } (L) = I\,\omega.$$

With a *moment of inertia* (I^{H}) already given on *page 3* as $\boldsymbol{5.23 \times 10^{-64}\ kg\ m^2}$ and an *angular velocity* (ω) of just ***1.047 rad.*** $\boldsymbol{s^{-1}}$**,** the *angular momentum* (L) of each 'H' face 2D membrane becomes:

$$5.23 \times 10^{-64}\ kg\ m^2 \times 1.047\ rad.\ s^{-1}$$

$$\boldsymbol{L^{H} = 5.47 \times 10^{-65}\ kg\ m^2\ s^{-1}}$$

As the teddy's boundary chords are split in two during *Stage 2* reconfiguration, part of the original angular momentum that was *face-spin bias* - would be transferred to the newly configured circular 'S' chords that now replace these (formerly) square faces. With its total of seven *rotational groups*, the teddy at this stage can be thought of as a tiny set of inter-locking 'cog-wheels' and the *points of convergence* (*POC's*) are the areas where these cogs mesh. Putting the *spin-conflict* to one side for the moment, the rotation of a larger 'H' face cog will directly influence the rotation of a smaller 'S' face cog and both must therefore exhibit the same ***linear speed*** at the *POC*. As *linear speed* is constant and is determined by the angular velocity multiplied by the radius, or:

$$\boldsymbol{v = \omega r}$$

then for the 'H' face, this will equate to:

$$v = 1.047\ rad.\ s^{-1} \times 8.66 \times 10^{-17}\ m.$$

So therefore, in this particular exercise:

$$\boldsymbol{v^{H} = 9.06 \times 10^{-18}\ m\ s^{-1}}$$

Similarly - the same can be said for the 'S' face and assuming the *same* linear speed at the *POC*, one will need to define its *angular velocity* in terms of that of the 'H' face so:

$$\frac{v}{r} = \omega, \quad \text{or} \quad \frac{9.06 \times 10^{-17}\ m\ s^{-1}}{5.00 \times 10^{-17}\ m} = 1.81\ s^{-1}$$

The *angular velocity* (ω) of the 'S' face thus becomes ***1.812 rad.*** $\boldsymbol{s^{-1}}$ as a consequence of having the same *linear speed* as that of the 'H' face (measured at the mutual *POC*) and the *angular momentum* of the 'S' face 2D membrane can now be calculated in a similar way - and this in turn will equate to:

$$I\omega, \text{ or } 1.16 \times 10^{-64}\ kg\ m^2 \times 1.81\ rad.\ s^{-1}$$

and therefore:

$$\boldsymbol{L^{S} = 2.10 \times 10^{-65}\ kg\ m^2\ s^{-1}}$$

The apparent difference in rotational speed between the 'H' face membrane and the 'S' face membrane at the *POC* can now be compared thus:

$$\text{'H'} = 1.047\ rad.\ s^{-1} \times 6 = \boldsymbol{2\pi} \text{ and,}$$

$$\text{'S'} = 1.81\ rad.\ s^{-1} \times 6 = 1.74 \times 2\pi = \boldsymbol{3.48\pi}$$

This will also give an estimated figure for the total original angular momentum of the teddy that would have been carried over from the *big-snap* as *face-spin bias* (bearing in mind that this value is solely based on our 'guesstimate' of the angular velocity of rotation) and within this particular exercise, this will amount to:

total 'H' face (L^H) = $5.47 \times 10^{-65}\ kg\ m^2\ s^{-1}\ \times\ 8$,

plus

total 'S' face (L^S) = $2.10 \times 10^{-65}\ kg\ m^2\ s^{-1} \times\ 6$

and this gives an original (hypothetical) angular momentum of:

$$\boldsymbol{L^O = 5.63 \times 10^{-64}\ kg\ m^2\ s^{-1}}$$

based on the assumption of an original *angular velocity of rotation* for the 'H' face membrane of a 2π rotation or *6.283* rad. s^{-1}.

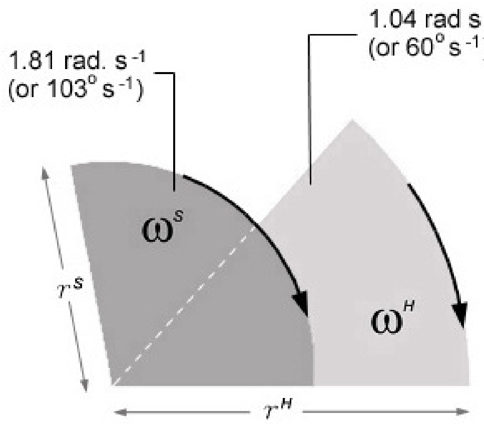

Figure 2.0.1 *A graphic comparison between the angular velocity of the 'S' face and 'H' face 2D membranes during the same unit of time.*

The difference between the two *angular velocities of rotation* (*ω*) of the 'H' and 'S' face membranes, can be used to provide a visual representation of these characteristics and this has been included as *Figure 2.01* above.

A direct comparison of the two linear speeds will show that any particular point on the circumference of the 'S' face membrane, will cover 1.74 times the distance of a comparable point on the circumference of the 'H' face membrane in the same unit of time, because:

$$\frac{\boldsymbol{\omega}^S}{\boldsymbol{\omega}^H} = \frac{1.81\ radians\ s^{-1}}{1.04\ radians\ s^{-1}} = \boldsymbol{1.74}$$

This ratio will not change, regardless of the value applied to one or other of the membranes and this also helps when considering the possibility that these membranes may act like *spinorial objects*. The intriguing thing about these abstract entities is of course, their ability to change their sign from positive to negative when they undergo a complete rotation (through 2π). There may also be a vague theoretical connection between *spinors* - and this model's 2D membranes in terms of their *quaternion axes* which in the case of this spinorial function, would seem to increase from two, to four dimensions (and not from two to *three* as one might expect). A *spinor* would also seem to require a 'real-time' attachment to some fixed object (for it to work) and in the case of these membranes, this may be provided by their origin as two-dimensional condensate from three-dimensional boundary chords. One is therefore presented then, with a two-dimensional object – rotating in four-dimensional space – but attached to a three-dimensional object (this being the membrane's parent boundary chords around its circumference).

The ***angular velocity ratio*** defined above, actually becomes perfectly suitable for describing the function of this 'H' and 'S' face difference in terms of *spinors*. If a (base) 2π rotation – such as that of the 'H' face 2D membrane – produces a positive value, a comparable measure of rotation for the 'S' face membrane (during the same period of time); will produce a *negative* value, because the speed of rotation must be 1.74 times greater. The sign change however, is only supposed to occur in (complete) multiples of 2π – but in this case, the 'S' face membrane will actually result in a comparable rotation of 2π x 1.74, which amounts to circa **3.5π** in this scenario.

This may seem like a *strange* value for the rotational characteristics of these 'S' face membranes and this would be true if not for something that has been noticed while playing about with the implications of these spinors. Suffice to say that for the moment, this value seems to be acceptable in the sense that it actually seems to work fine. This will be explored further in what will be called the spinor's ***zone of tolerance*** in a later paper and the very fact that these rotational groups seem to behave like spinorial objects, will have important consequences when the subject of proton-proton bonding is discussed also in a later paper. For the time being, these 'S' face membranes - with a rotation of just under 4π would seem to be 'teetering on the edge' so to speak - and one could imagine an input of energy being introduced that would push these components once again into an area of *positive value* - relatively easily. This too, will have consequences during the bonding process that will ultimately provide the first elements proper within this 3D/4D universe.

Returning to the question of charge itself, the surface areas of the (now) circular 'H' and 'S' faces can be provided with the (approximate) values:

$$\underset{(H)}{2.356 \times 10^{-28}\ cm^2} \quad \text{and} \quad \underset{(S)}{7.854 \times 10^{-29}\ cm^2}$$

which each relate to a radius of:

$$\underset{(H)}{8.660 \times 10^{-15}\ cm} \quad \text{and} \quad \underset{(S)}{5.000 \times 10^{-15}\ cm}$$

respectively and the physical relationship between face size, actually corresponds quite closely to the difference in rotational speed. The *area of influence* (Δ) however (from which these surface areas are derived), has been shown to have a direct bearing on the calculation of angular momentum and thus rotation. It is this action of rotation of the 2D membranes *against* the face's specific boundary chords, that would in this model – seem to produces the teddy's (or now technically the proton's) element of charge and because of the conservation of angular momentum, the faster spin of the 'S' face membranes - produce *negative* charge because of the *spinorial* implications.

The elemental charge – or the unit of charge produced by a single proton, would in this model, now seem to be provided by a total of *seven* distinct components – or seven distinct *rotational groups*. These integral groups would correspond to the 'H' face pairs (4No.) and the 'S' face pairs (3No.) mentioned earlier – and the rotation of each of these components would need to produce its own specific (*coulomb*) value thus:

'H' pair component (↑) $= +5.340 \times 10^{-20}$ C

'S' pair component (↓) $= -1.780 \times 10^{-19}$ C.

As explored in *Tregellen [1], July 2007*; these values would seem to have a direct relationship to the *surface areas* of each of the faces (the 'H' pair component is three times greater than that for the 'S') *and* this relationship also extends to their *spin ratios*. These ratios and the 'S' and 'H' charge values indicated above, are all proportional to each other and there *IS* a common denominator that would seem to link the two together. This is best illustrated by dividing each of the above coulomb values by two - in order to arrive at a charge component that can be applied to *each* individual face – and this results in a *single face* coulomb value of:

$$2.670 \times 10^{-20}\ C\ \text{(H)} \quad \text{and} \quad 8.900 \times 10^{-21}\ C\ (S)$$

Each of these values can then be divided into the appropriate overall 'H' or 'S' face 2D membrane surface area (already provided above). The value for each 'H' face and 'S' face is an approximation at the moment and does not take into account any possible concavity or convexity in its structure, but does seem to be heading in the right direction. This common denominator can therefore be found thus:

$$\frac{2.356 \times 10^{-28}}{2.670 \times 10^{-20}} = \boldsymbol{8.824 \times 10^{-09}}$$

for the 'H' face 2D membranes - and similarly,

$$\frac{7.854 \times 10^{-29}}{8.900 \times 10^{-21}} = \boldsymbol{8.824 \times 10^{-09}}$$

for the 'S' face membranes.

Before this apparent coincidence can be explored further, a final (possible) characteristic of the *Stage 2* reconfigured teddy should be considered. This has to do with the *shape* of the rotating 2D membranes themselves and what may be the result of both a *centripetal effect* because of rotation – and a distortion caused by the presence of an electric field in turn, produced by these moving 2D membranes against their parent boundary chords. This will be called ***membrane convexity***.

Apart from the obvious effects on shape, the *major* consequence of this would be an increase in the membrane's surface area due to this additional convexity. Considering the scale of the teddy, this would not amount to much, but may be sufficient however to change the value of the 'common denominator' described on the above. A change of just a very small percentage in this figure for both the (now slightly convex) 'H' and 'S' face 2D membranes will increase the apparent 'strangeness' of this coincidence.

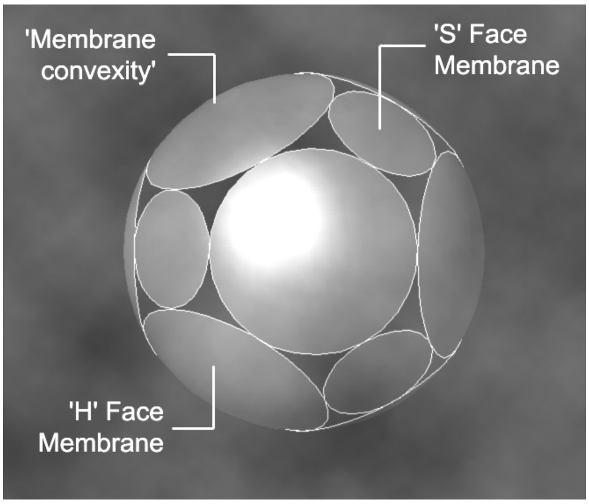

Figure 2.0.2 *Because of the centripetal effect of rotation and/or the influence of a resultant electric field, the teddy's 2D membranes may take on a characteristic very akin to convexity.*

This would almost (but not quite yet); allow this common denominator to correspond to the numerical value attributed in the 'real-world' to the ***permittivity of free space*** (ε_0) where originally 'ε' represented the ratio of electric displacement in a medium to the electric field intensity producing it. However, this is usually prescribed the value of $\boldsymbol{8.854 \times 10^{-12}\ F\ m^{-1}}$ which at the moment, is a full *THREE* orders of magnitude adrift from that of the common denominator arrived at on the previous page.

2.1 The 2D 'ε_0' Connection

Most linear measurements within this model have been given in *centimetres* and not in metres and this can adjust the above value by a magnitude of 10^2; but this would still leave a discrepancy of $\mathbf{10^1}$ because the value required for the common denominator is circa 8.854×10^{-09}. Can we assume however, that the effects of this ratio are being felt *JUST* within a three-dimensional environment (i.e. in the world where *we* make our measurements). These rotating 2D membranes by definition, *are not* technically three-dimensional; not in this model. They are certainly derived from the *de-gassing* of three-dimensional boundary chords, but this de-gassed material is actually *single* dimensional in origin; but must become two-dimensional because it is a *surface area*. This may sound confusing, but an area cannot comprise a single dimension simply because it is defined as length times breadth. This means that its value is derived from any two single-dimensional entities such as two adjacent or opposite single-dimensional ***de-gassing values***, (see again *Tregellen [1], July 2007*); where any two adjacent *areas of influence* can be said to produce a 2D membrane component such as *H1+H2; S1+S2; H4+H3; S3+S2* etc., etc..

The ***3D mass equivalence*** of such a two-dimensional body would therefore be a full magnitude *LESS* than it should be in our world, because of the simple cubic rule first described within *Paper 1* of this series. By the same token, three-dimensional effects, measurements (other than linear) and ratios, would be felt much more strongly by a *LESSER* 2D object such as the 'H' and 'S' face membranes that de-gas because of spin-conflict. In other words, one has to balance both sides of the dimensional equation and this can be achieved by using the analogy of the simple cubic rule again, first illustrated within *Tregellen [1], July 2007* (as *Figure 1.01*) and reproduced below as *Figure 2.1.1*.

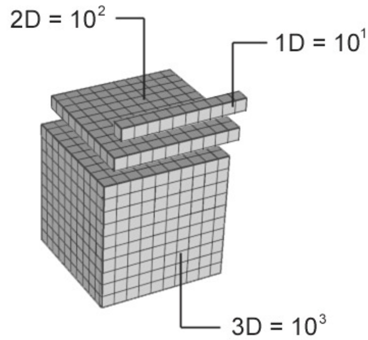

Figure 2.1.1 *Like length, area and volume in our world, the relationship between first, second and third dimensional energies can be likened to the values of a cube.*

One could say that the effects of 'ε_0' on the 3D world could be likened to the value given to all three planes of the cube – i.e. length x breadth x depth and therefore in this context, this could be expresses as:

3D Value of 'ε_0' = 1000 units (l x b x d)

while in order to arrive at the 2D equivalent where:

$$2D\ Value\ of\ `\varepsilon_0\text{'} = 100\ units\ (l \times b)$$

and in order to balance both sides:

$$\frac{1000\ units\ (3D)}{\mathbf{10}} = 3D\ Value\ of\ `\varepsilon_0\text{'}\ \mathbf{x\ 10}$$

We must therefore multiply 'ε_0' by ten to arrive at the correct magnitude *felt* by the 2D membranes thus:

$$8.854 \times 10^{-10} \times 10 = 8.854 \times 10^{-09}$$

3.0 The Calculation Of Charge

This conversion will now give a value that will allow the completion of the charge expression for the 'boundary chord' proton, which in terms of the individual component face membranes, now becomes:

$$Q\,\varepsilon_0 = A$$

where Q represents the charge (Coulomb); ε_0 the (corrected) permittivity of free space value; and A the 2D membrane area - and this becomes:

$$2.670 \times 10^{-20} \times 8.854 \times 10^{-09} = \mathbf{2.364 \times 10^{-29}}$$

for each 'H' face membrane and:

$$8.900 \times 10^{-21} \times 8.854 \times 10^{-09} = \mathbf{7.880 \times 10^{-29}}$$

for each 'S' face membrane.

Both results are in square centimetres and represent a surface area that is *1.004* and *1.003* times larger respectively, than those required for a simple 'flat' 2D membrane. This also represents a difference in accuracy from the originally calculated areas of less than half of one percent in each case. When one considers the very scale at which these membranes would sit in this model, the possibility of convexity must at present still remain debatable.

We are however, now presented with definable values of charge for each of the 'H' and 'S' faces of the proton; brought about the rotation of their corresponding 2D membranes within the confines of the face boundary chords. With a different *angular velocity of rotation*, each type (the 'H' and the 'S') can be allotted either a positive or a negative charge which in this case, would seem to suggest a *negative* for the 'S' because of its spinorial implications. We are thus able to calculate the overall charge on the proton as follows:

$$\frac{(8A^H)}{\varepsilon_0} = Q^{H+}$$

which predicts a *positive* charge for the total 'H' face membranes and,

$$\frac{(6A^S)}{\varepsilon_0} = Q^{S-}$$

for the *negative* 'S' face membranes; where A^H is the individual 'H' face membrane area; A^S the individual 'S' face membrane area; Q^{H+}, the resulting overall *positive* 'H' face Coulomb value and Q^{S-} the corresponding *negative* overall 'S' face Coulomb value. By using the original surface areas and ignoring for the moment the still debatable *membrane convexity*; we can calculate the resultant proton charge thus:

$$\frac{(8 \times 2.356 \times 10^{-28})}{8.854 \times 10^{-09}} = \mathbf{2.128 \times 10^{-19}\ Q^{H+}}$$

for the total 'H' face Coulomb value and,

$$\frac{(6 \times 7.854 \times 10^{-29})}{8.854 \times 10^{-09}} = \mathbf{5.322 \times 10^{-20}\ Q^{S-}}$$

for the (negative) 'S' face Coulomb value. This will now provide the boundary chord proton with an overall charge of:

$$\begin{array}{r} 2.128 \times 10^{-19} \\ -\ 5.322 \times 10^{-20} \\ \hline \mathbf{1.596 \times 10^{-19}\ Q^{N+}} \end{array}$$

where Q^{N+} represents here, the Coulomb value attributed to the proton *without* the component of *membrane convexity* taken into consideration.

4.0 The Component Of Spin

The symmetry of the tetrakaidecahedron (either the original *or* the reconfigured versions in this model), is such that each pair of parallel faces are also perfectly in line with each other. This produces a situation where the reconfigured teddy (either proton or neutron), can be perfectly superimposed upon the surface of a suitably scaled sphere and each member of a rotational group (the round faces) will scribe out a perfect segment (see *Figure 4.0.1* below).

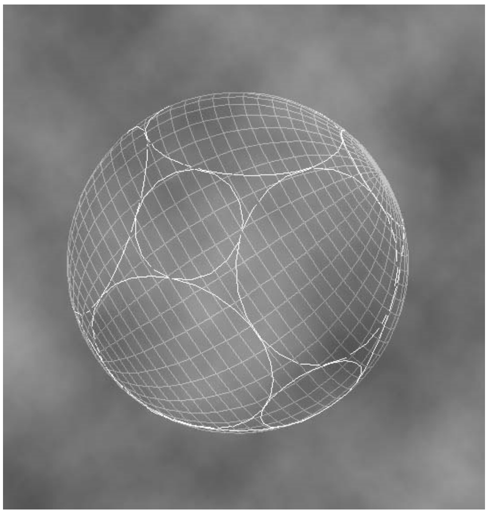

Figure 4.0.1 *The spherical symmetry of the reconfigured teddy superimposed upon a sphere of suitable scale.*

This aspect of the teddy, may be of assistance when describing the function of these rotational groups – especially when the subject of proton-to-proton bonding is discussed (dealt with in a later paper). Because of this perfect fit as it were, the mapping of these faces may also be possible in terms of the 'Reimann sphere'. This approach may be useful in trying to determine the 'spin' characteristics of this model's proton – which *must* have a direct relationship to the *rotational groups* from which it is comprised and this question will be tackled next.

Each component 'loop' of any particular rotational pair is ***orthogonal*** to its partner; which in this context can be taken as meaning *opposite*. Each *loop* (made up from its constituent *boundary chord values*) also has a component of rotation brought about by the imposed *face-spin bias* discussed earlier and because of the teddy's geometry, this rotation will be *complimentary* about the same axis and because they *are* orthogonal, these components could be described as possessing 'spin' as they rotate around a 'shared' axis. As this type of arrangement is reminiscent of the quantum geometry of the individual spin states of such massive particles as the electron, proton and neutron in convention (spin-½), then it may be possible to represent any chosen rotational group in terms of the *Reimann sphere* – where this surface can represent ***projective space*** [2] ($\mathbb{P}H^2$) and each point on this sphere can possess a distinct spin-½ state. With a rotational group's axis orientated north to south and for this exercise and arbitrarily attributed with a clockwise rotation; the spin conditions of its two component loops can be conventionally described as:

spin-up $|\uparrow\rangle$
(r/handed about the upward vertical) and,

spin-down $|\downarrow\rangle$
(r/handed about the downward vertical).

The ***spin states*** (which have an intimate relationship with the complex numbers ψ_0 and ψ_1 where usually $\psi_0 = w$ and $\psi_1 = z$); can therefore be described as {1,0} for *spin-up* and {0,1} for *spin-down* and these two (basic) states are themselves orthogonal (opposites). One is therefore presented with a picture very similar in nature to that shown in *Figure 4.0.1* opposite, although this particular sphere will be describing just *ONE* of these rotational group instead of all seven pairs - and this has itself been illustrated as *Figure 4.0.2* below.

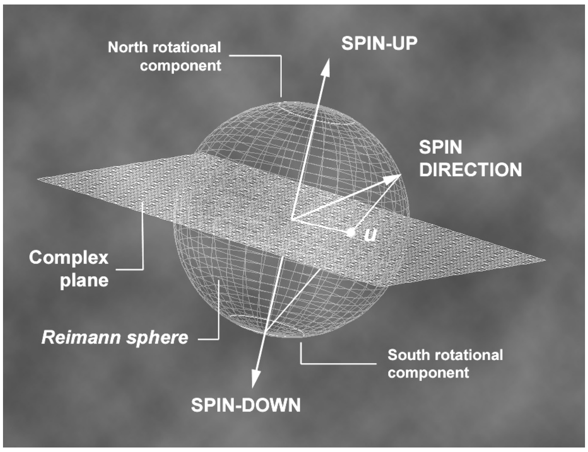

Figure 4.0.2 *The spin direction or spin-½ state of a rotational group can be ascertained by considering it as a Reimann sphere cut through the equator by the complex plane. The sphere itself becomes projective space.*

The Reimann sphere[3] in this particular usage, will include a 'complex plane' because of *w* and *z* and this will quite naturally, cut the equator of the sphere itself. As the surface of the Reimann sphere represents *projective space*, it should be possible therefore, to determine ***spin-direction***.

This has a relationship with the complex-plane, where:

$$w\,|\uparrow\rangle \;+\; z\,|\downarrow\rangle \;=\; |\nearrow\rangle$$

and where the sign '$\nearrow$' can be made to represent some direction in space; which in turn will be found to be some point on the surface of the Reimann sphere (now actually defined as *projective space* $\mathbb{P}H^2$). Not only does projective space become a Reimann sphere – but the teddy's rotational group itself could also be considered as a Reimann sphere too – especially in this particular context.

With the complex plane cutting the equator of the Reimann sphere, stereographic projection can be used to plot $|\nearrow\rangle$ (the spin direction or spin-½ state in projective space) and the position where this projection cuts the complex plane, will correspond with the complex number 'u' and the complex plane itself (the equatorial plane in stereographic projection), can now be considered as being representative of the ratio $u = z/w$.

5.0 Discussion

Within the bounds of this particular exercise, the illustration of a single rotational group by way of the Reimann sphere would seem to mirror that of any other spin-½ system – and the determination of *spin direction* would also seem to be achievable. The teddy (or proton) in this model however, is actually a system with a total of *SEVEN* rotational groups (or actually *4 x 'H'* and *3 x 'S'* groups). This would seem to complicate matters somewhat, so that the simple picture painted within *Figure 4.0.1* above is not quite the whole story.

These rotational groups also raise another more fundamental question as to the nature of the proton. Their origin was briefly touched upon in *Tregellen [1], July 2007* - as part of a series of evolutionary stages known as *dimensional differentiation* within the Boundary Chord Model and this aspect will be tackled more fully in the next of these papers (*Tregellen [3], August 2007*). The question above however, has everything to do with the inherent geometry of the reconfigured proton *and* of course, the ability of these rotational groups to be responsible for its component of charge. Thus far, there seems to be little evidence to suggest the presence of the *quarks* within this model and this will no doubt raise one or two eyebrows. The quarks have always been elusive at the best of times and it is reasonable to go as far as saying that the proton seems to work much better without its mysterious trio of elusive sub-atomic particles and becomes much simpler to boot. There has always been a certain fascination with the quarks and they appear to be the most stubborn of individuals. They continue to defy examination and are perhaps the least responsive to probing of all the sub-atomic particles. In 'The Second Creation' (Robert P. Crease and Charles C. Mann[4]) the authors include what is a rather poignant paragraph describing the nature of these animals and to quote:

"One can speculate endlessly about whether there are particles that can be subdivided infinitely. Quantum chromodynamics does not pretend to answer the question. In the manner of science, however, it does provide a definite answer to what happens when you actually go out and try to do so with the basic components of our world, hadrons. Suppose you begin shooting electrons at a proton, trying to knock loose one of its constituent quarks. As the quark is kicked further away from its partners, something strange occurs; the virtual gluons whirling between the quarks begin exchanging gluons among themselves. The greater the separation, the more intricate and powerful the web of interactions. Eventually, the energy needed to separate the quarks still farther from the snarl of gluons becomes sufficiently great that a new quark-antiquark pair is created *ex nihilo* from the vacuum. The antiquark bonds to the quark separating from the proton to create a meson; the new quark meanwhile pops right back into the proton, leaving it with the same number of quarks as before."

There also seems to be the possibility that a *polarity-flip* may occur between these different groups during nucleosynthesis (again, tackled in a later paper) and the Reimann sphere pictured in *Figure 4.0.1* becomes more than just a little cluttered. If the determination of spin direction is reliant on more than just one axis of rotation (each with its own 'spin-up' and 'spin-down' component), then in real life, we may be observing only *part* of the whole at the moment. This may infer that the *true* character of the nucleus may involve interactions that are not between just three distinct particles – but between active almost 'cog-like' components that rotate as complimentary pairs within a unique system of inter-related parts (actually thirty-six, three-dimensional parts). It may be complicated purely by the fact that experimenters are looking for quarks that aren't really there. As they say, only time will tell.

The apparent connection between the calculated surface areas of this model's proton and the (dimensionally corrected) value given to the *permittivity of free space* is a strange one. If one happens to believe in coincidence (which doesn't really have any place in science); this may simply be one of those chance occurrences – but when one considers that this value is actually a natural ratio involving the displacement of an electric field, these *rotational groups* and the charge they produce within this model, begin to appear more plausible.

6.0 References

1. Penrose R. (2004); Section **11.3** Geometry of quaternions *'The Road To Reality – A Complete Guide To The Laws Of The Universe'*; Jonathan Cape 2004.
2. Penrose R. (2004); Section **15.6** Projective spaces in *'The Road To Reality – A Complete Guide To The Laws Of The Universe'*; Jonathan Cape 2004.
3. Penrose R. (2004); Section **8.3** The Riemann Sphere and especially ***Fig. 8.7*** which provided the source for this chapter's *Fig. 4.0.2* on page 9 in *'The Road To Reality – A Complete Guide To The Laws Of The Universe'*; Jonathan Cape 2004.
4. R. P. Crease & C. C. Mann (1986) Chapter **16** Killing the Hydra (Part II) in *'The Second Creation'* Quartet Books 1997.