Quarks

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SU(2) and the Pauli Matrices

Fermions

The following analysis was suggested by the trigonometric model of Dan Shawen et. al. which was originally suggested as a model for fermions. Although it fails (in my opinion), I consider it a valiant effort in interpreting my own derivation as an extension of an alternative fermion model which will be produced shortly, with a re-interpretation of the Stern-Gerlach experiment in which SU(2) is used as the theoretical foundation for electron spin.

Consider the relations:

$$\varphi_L := R_z + r_x$$
$$R_z := (R_z)\cos\theta_z$$
$$r_x := r_x \sin\theta_z$$

Initial state: $\theta_z = 0,\ \theta_x = \dfrac{\pi}{4}$

In three dimensions (x, y, z) each axis is defined by the following "vectors", each in their own dimension (i.e., as first order), defined by their intersections at a common origin.

$y \equiv (\uparrow,\downarrow) \equiv (U, D)$ (Up, Down)

$x \equiv (\otimes,\odot) \equiv (I, O)$ (In, Out)

$z \equiv (\rightarrow,\leftarrow) \equiv (L, R)$

For a radius in each dimension, the interaction circumference is defined in the two planes orthogonal to the axes at equal distances from the origin. These circumferences can be imagined as the interaction of two spherical volumes at the ends of each axis (6 spheres in total), with the circumferences starting at zero for non-interacting spheres, and increasing to all equal radii when the spheres are completely merged.

Each pair of parameters on an axis represents an equal and opposite force, so that the pair taken together represents mass. For a sphere, the three dimensions of mass are equal. This is related to the diameter D and the radius r as each axis in the sphere.

$$f = \frac{f}{2} + \frac{f}{2} \equiv \frac{D}{2} + \frac{D}{2} \equiv r + r$$

$$m_0 = f^2 = \left(\frac{f}{2} + \frac{f}{2}\right)^2 = \left[\left(\frac{f}{2}\right)^2 + \left(\frac{f}{2}\right)^2\right] + \left[2\left(\frac{f}{2}\right)\left(\frac{f}{2}\right)\right],$$

Where $\left[\left(\frac{f}{2}\right)^2 + \left(\frac{f}{2}\right)^2\right]$ represents existence and $\left[2\left(\frac{f}{2}\right)\left(\frac{f}{2}\right)\right]$ represents the interaction of the forces.

If there are no interactions trigonometric analysis is applied then the volumes of the spheres are imaginary, since the axes are then affine (have no common origin). If the axes interact, then in two dimensions:

$$\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}} = \left[(r_\rightarrow) + (r_\uparrow)\right] + \left[(r_\leftarrow) + (r_\downarrow)\right]$$

$$\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2 = \left\{\left[(r_\rightarrow)^2 + (r_\uparrow)^2\right] + 2(r_\rightarrow)(r_\uparrow)\right\} + \left\{\left[(r_\leftarrow)^2 + (r_\downarrow)^2\right] + 2(r_\leftarrow)(r_\downarrow)\right\}$$

$$\pi\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2 = \left\{\left[\pi(r_\rightarrow)^2 + \pi(r_\uparrow)^2\right] + \left[(r_\rightarrow)\left(2\pi(r_\uparrow)\right)\right]\right\} + \left\{\left[\pi(r_\leftarrow)^2 + \pi(r_\downarrow)^2\right] + \left[(r_\leftarrow)\left(2\pi(r_\downarrow)\right)\right]\right\}$$

Where the existence terms $\left[\pi(r_\rightarrow)^2 + \pi(r_\uparrow)^2\right]$ and $\left[\pi(r_\leftarrow)^2 + \pi(r_\downarrow)^2\right]$ are the areas of circles and the interaction terms $\left[(r_\rightarrow)\left(2\pi(r_\uparrow)\right)\right]$ and $\left[(r_\leftarrow)\left(2\pi(r_\downarrow)\right)\right]$ suggest the product of a opposite radii and circumferences in the planes orthogonal to them.

The complete set is expressed as:

$$\pi\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2 = \left\{\left[\pi(r_\rightarrow)^2 + \pi(r_\uparrow)^2\right] + \left[(r_\rightarrow)\left(2\pi(r_\uparrow)\right)\right]\right\} + \left\{\left[\pi(r_\leftarrow)^2 + \pi(r_\downarrow)^2\right] + \left[(r_\leftarrow)\left(2\pi(r_\downarrow)\right)\right]\right\}$$

$$\pi\left(\varphi_{\{\rightarrow,\leftarrow\}\{\odot,\otimes\}}\right)^2 = \left\{\left[\pi(r_\rightarrow)^2 + \pi(r_\odot)^2\right] + \left[(r_\rightarrow)\left(2\pi(r_\odot)\right)\right]\right\} + \left\{\left[\pi(r_\leftarrow)^2 + \pi(r_\otimes)^2\right] + \left[(r_\leftarrow)\left(2\pi(r_\otimes)\right)\right]\right\}$$

$$\pi\left(\varphi_{\{\uparrow,\downarrow\}\{\odot,\otimes\}}\right)^2 = \left\{\left[\pi\left(r_\uparrow\right)^2 + \pi\left(r_\odot\right)^2\right] + \left[\left(r_\uparrow\right)\left(2\pi\left(r_\odot\right)\right)\right]\right\} + \left\{\left[\pi\left(r_\downarrow\right)^2 + \pi\left(r_\otimes\right)^2\right] + \left[\left(r_\downarrow\right)\left(2\pi\left(r_\otimes\right)\right)\right]\right\},$$

suggesting (non-interacting) Quarks.

Note that the left side are prime numbers, since

$$\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2 = \left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2 \left(\frac{\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2}{\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2}\right) = \left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2 \left(1_{\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right)^2}\right)$$

A system of interacting quarks is then suggested by:

$$\Psi = \left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right) + \left(\varphi_{\{\rightarrow,\leftarrow\}\{\odot,\otimes\}}\right) + \left(\varphi_{\{\uparrow,\downarrow\}\{\odot,\otimes\}}\right)$$

$$\Lambda := \left(\frac{4\pi}{3}\right)$$

$$\left(\Lambda\Psi^3\right) = \left(\frac{4\pi}{3}\right)\left[\left(\varphi_{\{\rightarrow,\leftarrow\}\{\uparrow,\downarrow\}}\right) + \left(\varphi_{\{\rightarrow,\leftarrow\}\{\odot,\otimes\}}\right) + \left(\varphi_{\{\uparrow,\downarrow\}\{\odot,\otimes\}}\right)\right]^3$$

$$:= \left(\Lambda\right)\left(r + b + g\right)^3$$

$$= \left[\Lambda r^3 + \Lambda b^3 + \Lambda g^3\right] + 3\Lambda\left(br^2\right) + 3\Lambda\left(gr^2\right) + 3\Lambda\left(rb^2\right) + \Lambda\left(gb^2\right) + 3\Lambda\left(rg^2\right) + 3\Lambda\left(bg^2\right) + 6\Lambda\left(rbg\right)$$

$$= \left[\Lambda r^3 + \Lambda b^3 + \Lambda g^3\right] + 4\left[b\left(\pi r^2\right) + g\left(\pi r^2\right) + r\left(\pi b^2\right) + g\left(\pi b^2\right) + r\left(\pi g^2\right) + b\left(\pi g^2\right) + 2\pi\left(rbg\right)\right]$$

In one dimension,

$$|r+0| = |r|, |r+0|^2 = |r|^2, Tr|r| = r$$

In two dimensions

$$\# = r + b$$

$$\#^2 = \left(r+b\right)^2 = \left[r^2 + b^2\right] + \left[2rb\right] = Tr\begin{vmatrix} r & 0 \\ 0 & b \end{vmatrix}^2 + Det\begin{vmatrix} r & r \\ -b & b \end{vmatrix}$$

If interaction with a third particle causes the separation of terms on the right, then

$$(\#')^2 = \left(r'+b'\right)^2 = \left[r'^2\right] + \left[b'^2\right] + \left[2r'b'\right] = \left(r'\right)^2 + \left(b'\right)^2 + \left(g'\right)^2 \text{ where}$$

$$\left[2r'b'\right] := 2S^2 = h^2,\ S^2 = r'b', S = \frac{h}{\sqrt{2}}$$

These elements can then interact as odd and even counts, where (e.g.):

$Odd + Even = r'^2 + (b' + g')^2$ where each element is prime.

Think of it this way:

One real dimension,
$a+0=a$ (existence) (mass)

First Order (existence)
Two dimensions, $\# := a+a=2a,\ a-a=0,\ a=a$ (existence) a dies not interact (multiply) a in first order
Second Order (existence + Interaction, Change in entropy, entanglement)

It is only in second order that multiplication between two elements is defined: where:

$$\left(\#^2\right)_{(2+,2\times)} = (a+a)^2 = [(a)^2+(a)^2]+\left[2(a)(a)\right]$$
$$= Tr\begin{vmatrix}(a)^2 & 0 \\ 0 & (a)^2\end{vmatrix} + Det\begin{vmatrix}(a) & (a) \\ -(a) & (a)\end{vmatrix} = \left\{4(a)^2\right\}_{(2+,2\times)},$$

And $[(a)^2+(a)^2]$ represents existence and $\left[2(a)(a)\right]$ represents interaction

Distinguishable elements (a,b)

$$\left(\#^2\right)_{(2+,2\times)} = (a+b)^2 = [(a)^2+(b)^2]+\left[2(a)(b)\right]$$
$$= T\left\{r\begin{vmatrix}(a)^2 & 0 \\ 0 & (b)^2\end{vmatrix} + Det\begin{vmatrix}(a) & (a) \\ -(b) & (b)\end{vmatrix}\right\}_{(2+,2\times)}$$

(Fermat's Last Theorem for the case n=2)

Hypothesis

$\#^2 \neq a^2+b^2$

Proof

Assume: $\# = a+b$

$\left(\#^2\right) = [(a)^2+(b)^2] \leftrightarrow \left[2(a)(b)\right]=0$

$\left[2(a)(b)\right] \neq 0$

$\left(\#^2\right) \neq [(a)^2+(b)^2]$

QED

Note that this is not logically equivalent to the four-dimensional existence matrix where only addition is defined:

$$\psi := (a+b) + i(c+\mathrm{d}) = (a+b) + (c+\mathrm{d})$$

$$\psi\psi^* \; = \; ?$$

$$(\# > 4, etc., \; exercises \; for \; the \; student)$$

$$Tr(\#^2)_{(2+,2\times)} \sim\equiv Tr(\#^2)_{(4+)} = Tr\begin{vmatrix} (a) & 0 & 0 & 0 \\ 0 & (a) & 0 & 0 \\ 0 & 0 & (a) & 0 \\ 0 & 0 & 0 & (a) \end{vmatrix}^2 = (a)^2 + (a)^2 + (a)^2 + (a)^2 = \left\{4(a)^2\right\}_{(4+)}$$

Imaginary Coordinate $b := ib := b,\ i := \sqrt{-1}$

In the complex plane, the axes are orthogonal, which means the for the base vectors there is no common origin, i.e. $\overrightarrow{\sqrt{-1}} \cdot \overleftarrow{\sqrt{-1}} := \vec{i} \cdot \overleftarrow{\sqrt{-1}} = 0 \leftrightarrow \left(\vec{i} \cdot \overleftarrow{i}\right) \cdot \left(\overrightarrow{\sqrt{-1}} \cdot \overleftarrow{\sqrt{-1}}\right) = \overrightarrow{-1} \cdot \overleftarrow{1} = 0$, i.e.

$$\overrightarrow{-1} \perp \overleftarrow{1},\ \ 0 \sim\equiv 0,\ \left|\begin{matrix}0\\ \downarrow\end{matrix}\right| \sim\equiv \left|\begin{matrix}\uparrow\\ 0\end{matrix}\right|$$

(i.e., one of the a is imaginary, e.g., coordinate $b := x$)

$$\psi := a + ib := a + b$$
$$\psi^* := a - ib$$
$$\psi\psi^* = (a+ib)(a+ib) = \left[a^2 + b^2\right] + \left[(ab) - (ba)\right] = \left[a^2 + b^2\right] + \left[(0) - (0)\right],\ \left[(ab) = (ba) = 0\right],\ a \perp b$$
$$\psi\psi^* = \left[a^2 + b^2\right] \leftrightarrow b = \sqrt{-1},\ ab = ba = 0,\ a \perp b$$

Three dimensions

$$\# = a + b + c$$
$$\#^2 = (a+b+c)^2 = \left(a^2 + b^2 + c^2\right) + f(a,b,c,2)$$
$$\#^2 = \left(a^2 + b^2 + c^2\right) \Leftrightarrow f(a,b,c,2) = 0$$
$$f(a,b,c,2) \neq 0$$
$$\#^2 \neq \left(a^2 + b^2 + c^2\right) \quad \text{(Fermat's Theorem for Multinomials)}$$

$$\#^2 = a^2 + (b+c)^2$$

$$\psi := a + i(b+c) := a + (b+c)$$
$$\psi\psi^* = a^2 + (b+c)^2$$

Four Dimensions

$$\# := a + b + c + d$$
$$(\#)^2 = (a+b+c+d)^2 = (a^2 + b^2 + c^2 + d^2) + f(a,b,c,d,2) \quad \text{(Multinomial Theorem)}$$

$$\psi := a + i(b+c+d) = a + (b+c+d)$$
$$\psi\psi^* = a^2 + (b+c+d)^2$$

And More:

$$\psi := (a+b)+i(c+\mathrm{d}) = (a+b)+(c+\mathrm{d})$$

$$\psi\psi^* \;=\; ?$$

$$\psi := (a+b+c)+i(d) = (a+b+c)+(d)$$

$$\psi\psi^* \;=\; ?$$

$$(\# > 4, etc., \; exercises\ for\ the\ student)$$