Interaction

(Entanglement, Entropy, Spin)

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This document is an attempt to clarify the concept of Spin as a change in entropy (i.e. Entanglement) and characterization this concept as a description of fundamental particles (boson, fermion, etc.)

Equal Forces

$$\# := f + f$$
$$(\#)^2 := \left[f^2 + f^2\right] + 2\left[ff\right]$$

$$2[ff] = \left(\sqrt{2[ff]}\right)^2 = 2\left(\sqrt{(-f)(-f)(f)(f)}\right)^2$$

$$f^+ := f \sin\theta,\ \theta = \frac{\pi}{4}$$

$$-f^- = \sin\left(-\frac{3\pi}{4}\right) = -\sin\left(\frac{3\pi}{4}\right)$$

$$2\left(\sqrt{\left[\left(f^-\right)\left(f^-\right)\right]\left[\left(f^+\right)\left(f^+\right)\right]}\right)^2 = 2\left(\sqrt{\left[(f)^2\right]\left[(f)^2\right]}\right) = 2ff = |ff| + |ff|$$

Bosons

Note: the above characterization applies to $2(1/2)ff = (1)ff$ of the RUC $0 \le \theta < (\pi)$ (CCW) and $\pi \le \theta < (2\pi)$ (CCW) and so characterizes a Spin 1 Boson (two quadrants $2(1/2)$ of the RUC); with the other two quadrants comprising the second Boson.

The Entanglement (Entropy, multiplicative interaction) can then be characterized as

$$h^2 = 2ff = 2S^2$$

$$h^2 = 2S^2 = 2(f)^2,\ S := f = \frac{h}{\sqrt{2}}$$

These are the color**s** when the forces detach from each other

$(\#)^2 := \left[f^2 + f^2\right] + 2ff = \left[f^2 + f^2\right] + \left|f^- f^-\right| + \left|f^+ f^+\right|$ to

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

Note that because the identity holds for the sum of the 2x2 matrices, the expression cannot be manifestly covariant.

Unequal Forces

("Trigonometric Analysis): Final state $1_{(c\tau')^2} = \left(1_{(c\tau')}\right)^2$

$$\# := (c\tau') = (c\tau) + (v\tau')$$

$$\frac{(\#)^2}{(\#)^2} = \frac{(c\tau')^2}{(c\tau')^2} = 1_{(c\tau)^2} = \left(\frac{1}{\gamma}\right)^2 + \beta^2 + 2\frac{\beta}{\gamma},\ \gamma = \frac{\tau'}{\tau},\ \beta = \frac{v}{c},\ \beta < \gamma$$

$$(\delta)^2 := \left[\left(\frac{1}{\gamma}\right)^2 + \beta^2\right] - 2\frac{\beta}{\gamma}$$

Note the correspondence of the expression $1_{(c\tau)^2} = \left(\frac{1}{\gamma}\right)^2 + \beta^2$ with the trigonometric identity

$1_{(c\tau)^2} = \left(1_{(c\tau)}\right)^2 = \cos^2\theta + \sin^2\theta$. However, the expression cannot be derived from the expression

$\left(1_{(c\tau)}\right) = \cos\theta + \sin\theta$ which requires the complex expression

$$\psi := \cos\theta + i\sin\theta$$
$$\psi^* := \cos\theta - i\sin\theta$$

With the complex conjugate expressed as

$$\psi\psi^* := \cos^2\theta + \sin^2\theta \leftrightarrow i = \sqrt{-1}$$

This expression is invalid for positive real numbers, since if negative numbers $i^2 = -1$ are not allowed, then neither are their square roots.

("Hyperbolic Analysis"): Initial State $1_{(c\tau)^2} = \left(1_{(c\tau)}\right)^2$

$$1_{(c\tau)^2} := \frac{(c\tau)^2}{(c\tau)^2}$$

$$\frac{(\#)^2}{(\#)^2} = \gamma^2 = 1_{(c\tau)^2} + (\gamma\beta)^2 + 2(\gamma\beta),\quad \gamma = \frac{\tau'}{\tau},\ \beta = \frac{v}{c},\ \beta < \gamma$$

Note the correspondence of the expression $\gamma^2 = \left(1_{(c\tau)}\right)^2 + (\gamma\beta)^2$ with the hyperbolic identity:

$$\cosh^2\theta = 1^2 + \sinh\theta^2$$

As in the trigonometric case, a complex identity must be applied to derive this expression, again which refers to negative numbers.

$$\# := f + f'$$
$$(\#)^2 := \left[f^2 + (f')^2\right] + 2[ff'] \pm \delta^2$$

For $\left[f^2 + (f')^2\right] > 2[ff']$

$+\delta^2$ is the correction necessary to return the expression to equal forces

$\left[f^2 + (f')^2\right] < 2[ff']$

$-\delta^2$ is the correction necessary to return the expression to equal forces.

$$(\#)^2 := \left[f^2 + (f')^2\right] + 2[ff'] \pm \delta^2 = Tr\begin{vmatrix} f^2 & 0 & 0 & 0 & 0 \\ 0 & f^2 & 0 & 0 & 0 \\ 0 & 0 & ff^- & 0 & 0 \\ 0 & 0 & 0 & ff^+ & 0 \\ 0 & 0 & 0 & 0 & \pm\delta^2 \end{vmatrix}$$

$$(\#)^2 = Tr\begin{vmatrix} (f)^2 & 0 \\ 0 & (f')^2 \end{vmatrix} + Det\begin{vmatrix} f & f \\ -f & f \end{vmatrix} \pm Det\begin{vmatrix} \sigma & 0 \\ 0 & \sigma \end{vmatrix}$$

Entanglement and the RUC

The focus now turns to the entanglement (entropy) term in the RUC, and so it will be assumed that the terms are the green entanglement term above, where black has been applied for clarity. There are two types of entanglements:

1. "Cartesian" representation: $(c\tau)$ and $(v\tau')$ are inscribed in the RUC; $"\pm"(c\tau)$ horizontally at the center origin and $(v\tau')$ vertically, where the $(v\tau')$ can be either at the common origin of all four quadrants, or at both ends of; in the discussion that follows, the ends are used, with the angle θ between $(c\tau)$ and the hypotenuse. Note that the hypotenuse is not calculated, since only the legs of the triangle figure in calculating the area of each triangle $\frac{1}{2}(c\tau)(v\tau')$ in determining the total "entanglement" $4\left(\frac{1}{2}(c\tau)(v\tau')\right)=2(c\tau)(v\tau')$. The squares of the legs form the "existence" part of the equation.
2. "Radial" representation: In this case, the "count" is multiplied by π, so the "existence" elements are circular disks and the "entanglement" term is the initial condition (radius r) multiplied by a Circumference $C=2\pi r'$ so the total entanglement is $rC=(r)(2\pi r')$
3. Cartesian and radial representations can be combined in a single interaction.

"Trigonometric" Analysis ("Cartesian Coordinates") $0<(ct)^2,(v\tau')^2\le 1_{(c\tau')^2}=\frac{(c\tau')^2}{(c\tau')^2}$

The RUC is divided into four quadrants, where increasing entropy for each quadrant is defined in terms of the following changes in θ for

$h^2=2S^2=2f\cos\theta f'\sin\theta=2(ff')\cos\theta\sin\theta$ the interactive spin $S_i:=(ff')_i\ i=I,II,III,IV$ for each of the four quadrants:

$$h=\sqrt{2}S=\sqrt{2}\left[f\cos\theta f'\sin\theta\right]=\sqrt{2}\left[(ff')\cos\theta\sin\theta\right]$$
$$S=\frac{h}{\sqrt{2}}$$

$$h^2=\frac{1}{4}h_I+\frac{1}{4}h_{II}+\frac{1}{4}h_{III}+\frac{1}{4}h_{IV},\ S_i=(\cos\theta\sin\theta),i=I,II,III,IV$$

Spin

Higgs Boson (Spin 0):

$$h^2 = 2S^2 = \left[f\cos\left(\frac{\pi}{4}\right) f\sin(0) \right] + \left[f\cos\left(\frac{3\pi}{4}\right)\sin(\pi) \right] = (2ff)\left[(0)^2(0)^2\right] = 0$$

$$\# = f, \quad h^2 = 2S^2 = 2ff = 0$$

$$\#^2 = f^2$$

$$N(\#)^2 = N(f)^2, \quad N = 1,2,3,....$$

Fermions, Quarks, Leptons, $\frac{1}{2}(S)^2$ **(Spin (1/2)**

$$h^2 = 2S^2 = \left\{ \left[\frac{1}{4}(S_I)^2 + \frac{1}{4}(S_{III})^2 \right] + \left[\frac{1}{4}(S_{II})^2 + \frac{1}{4}(S_{IV})^2 \right] \right\}$$

$$= 2\left\{ \frac{1}{2}(S_{I,III})^2 + \frac{1}{2}(S_{II,IV})^2 \right\} = 2\left\{ \frac{1}{2}(S)^2 \right\} = 2S^2$$

Bosons (Photons, W and Z Bosons, gluons Spin $(1)S^2$ **(Spin 1)**

$$(S_{I,III})^2 = (S_{II,IV})^2 = (1)S^2$$

$$(S_{I,III})^2 + (S_{II,IV})^2 = (1+1)S^2 = 2S^2$$

For increasing entanglement $\left(h^2\right)^{\uparrow}=2\left(S^2\right)^{\uparrow}$ (entropy, spin, interaction), $S:=f\leftrightarrow S^2=f^2$ θ varies as

$$\left(h_I{}^2\right)^{(\uparrow)}=\left(\frac{1}{2}S_I{}^2\right)^{(\uparrow)}=\frac{1}{2}\cos\theta\sin\theta, 0<\theta<\frac{\pi}{4}, (ccw)$$

$$\left(h_{II}{}^2\right)^{(\uparrow)}=\left(\frac{1}{2}S_{II}{}^2\right)^{(\uparrow)}=\frac{1}{2}\cos\theta\sin\theta, \pi<\theta<\frac{\pi}{4}, (cw)$$

$$\left(h_I{}^2\right)^{(\uparrow)}+\left(h_{II}{}^2\right)^{(\uparrow)}=\left(S^2\right)^{(\uparrow)}$$

follows:I $\left(h_{III}{}^2\right)^{(\uparrow)}=\left(\frac{1}{2}S_{IV}{}^2\right)^{(\uparrow)}=\frac{1}{2}\cos\theta\sin\theta, \pi<\theta<\frac{3\pi}{4}, (ccw)$

$$\left(h_{IV}{}^2\right)^{(\uparrow)}=\left(\frac{1}{2}S_{IV}{}^2\right)^{(\uparrow)}=\frac{1}{2}\cos\theta\sin\theta, \frac{3\pi}{4}<\theta<2\pi, (cw)$$

$$\left(h_{III}{}^2\right)^{(\uparrow)}+\left(h_{IV}{}^2\right)^{(\uparrow)}=\left(S^2\right)^{(\uparrow)}$$

$$\left(h^2\right)^{(\uparrow)}=\left(h_I{}^2\right)^{(\uparrow)}+\left(h_{II}{}^2\right)^{(\uparrow)}+\left(h_{III}{}^2\right)^{(\uparrow)}+\left(h_{IV}{}^2\right)^{(\uparrow)}=4\left(\frac{1}{2}\right)\left(S^2\right)^{(\uparrow)}=2\left(S^2\right)^{(\uparrow)}$$

For decreasing entanglement $\left(h^2\right)_{\downarrow}=2\left(S^2\right)_{\downarrow}$ (entropy, spin, interaction), $S:=f\leftrightarrow S^2=f^2$ θ varies as follows:

$$\left(h_I{}^2\right)_{\downarrow}=\left(\frac{1}{2}S_I{}^2\right)_{\downarrow}=\frac{1}{2}\cos\theta\sin\theta, 0<\theta<\frac{\pi}{4}, (cw)$$

$$\left(h_{II}{}^2\right)_{\downarrow}=\left(\frac{1}{2}S_{II}{}^2\right)_{\downarrow}=\frac{1}{2}\cos\theta\sin\theta, \pi<\theta<\frac{\pi}{4}, (ccw)$$

$$\left(h_I{}^2\right)_{\downarrow}+\left(h_{II}{}^2\right)_{\downarrow}=\left(S^2\right)_{\downarrow}$$

I $\left(h_{III}{}^2\right)_{\downarrow}=\left(\frac{1}{2}S_{IV}{}^2\right)_{\downarrow}=\frac{1}{2}\cos\theta\sin\theta, \pi<\theta<\frac{3\pi}{4}, (cw)$

$$\left(h_{IV}{}^2\right)_{\downarrow}=\left(\frac{1}{2}S_{IV}{}^2\right)_{\downarrow}=\frac{1}{2}\cos\theta\sin\theta, \frac{3\pi}{4}<\theta<2\pi, (ccw)$$

$$\left(h_{III}{}^2\right)_{\downarrow}+\left(h_{IV}{}^2\right)_{\downarrow}=\left(S^2\right)_{\downarrow}$$

$$\left(h^2\right)_{\downarrow}=\left(h_I{}^2\right)_{\downarrow}+\left(h_{II}{}^2\right)_{\downarrow}+\left(h_{III}{}^2\right)_{\downarrow}+\left(h_{IV}{}^2\right)_{\downarrow}=4\left(\frac{1}{2}\right)\left(S^2\right)_{\downarrow}=2\left(S^2\right)_{\downarrow}$$