# The relation of colour charge to electric charge

Dirac has shown how the Klein-Gordon equation can be factored into two linear parts using 4x4 Dirac gamma matrices.

*[Dirac, P.A.M., The Principles of Quantum Mechanics, 4th edition (Oxford University Press) ISBN 0-19-852011-5]*

$$(\partial_t^2 - \partial_x^2 - \partial_y^2 - \partial_z^2 + m^2)\, I = (-i[s\gamma^0\partial_t + r\gamma^1\partial_x + g\gamma^2\partial_y + b\gamma^3\partial_z] - w\,m\,I)\,(i[s\gamma^0\partial_t + r\gamma^1\partial_x + g\gamma^2\partial_y + b\gamma^3\partial_z] - w\,m\,I)$$

where r,g,b and s,w equal +1 or -1.

For leptons r,g,b all equal -1 and for quarks two of r,g,b are equal to +1 and the third equals -1. The signs are all negated for anti-particles as in the equation above.

When s = +1, count the number of plus signs (say) for r,g,b which is 0 for leptons and 2 for quarks.

When s = -1, count the number of minus signs (say) for r,g,b which is 3 for leptons and 1 for quarks.

For material particles r,g,b all equal -1 which is always true for leptons and true for three distinct quarks with r,g,b equal to -1 separately or a quark and an appropriate anti-quark.

Let $\hat{\gamma} = i\,\gamma_0\gamma_1\gamma_2\gamma_3\gamma_4$ where $\gamma_0$ , $\gamma_1$ , $\gamma_2$ , $\gamma_3$ , $\gamma_4$ are vectors which anti-commute and where:

$$\gamma_1^2 = \gamma_2^2 = \gamma_3^2 = -I \qquad \gamma_0^2 = \gamma_4^2 = I \quad .$$

Then: $\gamma_0\hat{\gamma} = \hat{\gamma}\gamma_0 \quad \gamma_1\hat{\gamma} = \hat{\gamma}\gamma_1 \quad \gamma_2\hat{\gamma} = \hat{\gamma}\gamma_2 \quad \gamma_3\hat{\gamma} = \hat{\gamma}\gamma_3 \quad \gamma_4\hat{\gamma} = \hat{\gamma}\gamma_4 \qquad \hat{\gamma}^2 = I$

Let: $\hat{s} = \frac{1}{2}(I + s\,\hat{\gamma}) \quad \hat{r} = \frac{1}{2}(I + r\,\hat{\gamma}) \quad \hat{g} = \frac{1}{2}(I + g\,\hat{\gamma}) \quad \hat{b} = \frac{1}{2}(I + b\,\hat{\gamma}) \quad \hat{w} = \frac{1}{2}(I + w\,\hat{\gamma})$

Then: $\hat{s}^2 = \hat{s} \quad \hat{r}^2 = \hat{r} \quad \hat{g}^2 = \hat{g} \quad \hat{b}^2 = \hat{b} \quad \hat{w}^2 = \hat{w}$

A charged particle moving in an electro-colour-weak field will have its partial derivatives $\partial_t$ , $\partial_x$ , $\partial_y$ , $\partial_z$ , $\partial_m$ modified by minimal coupling to become covariant derivatives $\nabla_t$ , $\nabla_x$ , $\nabla_y$ , $\nabla_z$ , $\nabla_m$ . Thus:

$$(\hat{s}\gamma_0\nabla_t + \hat{r}r\gamma_1\nabla_x + \hat{g}g\gamma_2\nabla_y + \hat{b}b\gamma_3\nabla_z + \hat{w}\gamma_4\nabla_m)\,(\hat{s}\gamma_0\nabla_t + \hat{r}r\gamma_1\nabla_x + \hat{g}g\gamma_2\nabla_y + \hat{b}b\gamma_3\nabla_z + \hat{w}\gamma_4\nabla_m)$$

$$= \hat{s}\nabla_t^2 - \hat{r}\nabla_x^2 - \hat{g}\nabla_y^2 - \hat{b}\nabla_z^2 + \hat{w}\nabla_m^2$$

$$+ \hat{s}\hat{w}\gamma_0\gamma_4(\nabla_t\nabla_m - \nabla_m\nabla_t)$$

$$+ \hat{s}\gamma_0[\hat{r}r\gamma_1(\nabla_t\nabla_x - \nabla_x\nabla_t) + \hat{g}g\gamma_2(\nabla_t\nabla_y - \nabla_y\nabla_t) + \hat{b}b\gamma_3(\nabla_t\nabla_z - \nabla_z\nabla_t)]$$ ( = 0 for a neutrino )

$$+ \hat{w}\gamma_4[\hat{r}r\gamma_1(\nabla_m\nabla_x - \nabla_x\nabla_m) + \hat{g}g\gamma_2(\nabla_m\nabla_y - \nabla_y\nabla_m) + \hat{b}b\gamma_3(\nabla_m\nabla_z - \nabla_z\nabla_m)]$$

$$+ \hat{r}r\hat{g}g\gamma_1\gamma_2(\nabla_x\nabla_y - \nabla_y\nabla_x) + \hat{g}g\hat{b}b\gamma_2\gamma_3(\nabla_y\nabla_z - \nabla_z\nabla_y) + \hat{b}b\hat{r}r\gamma_3\gamma_1(\nabla_z\nabla_x - \nabla_x\nabla_z)$$

$$= \hat{s}\nabla_t^2 - \hat{r}\nabla_x^2 - \hat{g}\nabla_y^2 - \hat{b}\nabla_z^2 + \hat{w}\nabla_m^2$$

$$+ \hat{s}\hat{w}\gamma_0\gamma_4 R(\partial_t, \partial_m)$$

$$+ \hat{s}\gamma_0[\hat{r}r\gamma_1 R(\partial_t, \partial_x) + \hat{g}g\gamma_2 R(\partial_t, \partial_y) + \hat{b}b\gamma_3 R(\partial_t, \partial_z)]$$ ( = 0 for a neutrino )

$$+ \hat{w}\gamma_4[\hat{r}r\gamma_1 R(\partial_m, \partial_x) + \hat{g}g\gamma_2 R(\partial_m, \partial_y) + \hat{b}b\gamma_3 R(\partial_m, \partial_z)]$$

$$- \hat{r}\hat{g}b\gamma_1\gamma_2 R(\partial_x, \partial_y) - r\hat{g}\hat{b}\gamma_2\gamma_3 R(\partial_y, \partial_z) - \hat{r}g\hat{b}\gamma_3\gamma_1 R(\partial_z, \partial_x)$$

where $R(\partial_u, \partial_v)$ is the Riemann Curvature Tensor in the $\partial_u$ and $\partial_v$ directions.
Gravity as curvature emerges from the interaction of the 5 bit electro-colour-weak charge with the electro-colour-weak field.