1) Paper 38: Second Part of Preparatory Notes.

Majorana Equation

The Majorana equation represents the free space equations of electromagnetism as Weyl equations, or Dirac equations with no mass term. The equations of electromagnetism used by the Majorana were the MH equations. In order to derive the correctly covariant Majorana equation the unified field theory is needed. The Weinberg equation is a generalization of the Majorana equation for any spin; half-integral or integral. The new Evans field theory represents all these spin equations in terms of the Evans wave equation.

In order to illustrate the approach consider the MH equations in free space. In S.I. units:

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \qquad -(1)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2}\frac{\partial \underline{E}}{\partial t} = \underline{0}. \qquad -(2)$$

These equations are used simply for the sake of illustration. As we know, the e/m eqns of the unified field theory have a different structure. Eqs (1) and (2) can be written as:

$$\underline{\nabla} \times \left(\underline{E} - ic\underline{B}\right) + \frac{i}{c}\frac{\partial}{\partial t}\left(\underline{E} - ic\underline{B}\right) = \underline{0} \qquad -(3)$$

Now consider the right and left circularly polarized solutions of eq. (3):

2)

$$\underline{E}^R = \frac{E^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j} \right) e^{i\phi}, \quad -(4)$$

$$\underline{B}^R = \frac{B^{(0)}}{\sqrt{2}} \left(i\underline{i} + \underline{j} \right) e^{i\phi}, \quad -(5)$$

and

$$\underline{E}^L = \frac{E^{(0)}}{\sqrt{2}} \left(\underline{i} + i\underline{j} \right) e^{i\phi}, \quad -(6)$$

$$\underline{B}^L = \frac{B^{(0)}}{\sqrt{2}} \left(-i\underline{i} + \underline{j} \right) e^{i\phi}. \quad -(7)$$

Use:

$$E^{(0)} = cB^{(0)} = \omega A^{(0)} \quad -(8)$$

to obtain:

$$\underline{E}^R - ic\underline{B}^R = 2\omega \frac{A^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j} \right) e^{i\phi}. \quad -(9)$$

Define the potential field as:

$$\underline{A}^R = \frac{A^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j} \right) e^{i\phi} \quad -(10)$$

so that

$$\boxed{\underline{E}^R - ic\underline{B}^R = 2\omega \underline{A}^R}. \quad -(11)$$

Similarly:

$$\boxed{\underline{E}^L + ic\underline{B}^L = 2\omega \underline{A}^L} \quad -(12)$$

where:

$$\underline{A}^L = \frac{A^{(0)}}{\sqrt{2}} \left(\underline{i} + i\underline{j} \right) e^{i\phi}. \quad -(13)$$

3) Eqns (11) and (12) define the right and left handed potential fields. These obey the eqs. :

$$\left(\underline{\nabla} \times + \frac{i}{c} \frac{\partial}{\partial t} \right) \underline{A}^R = \underline{0} \quad -(14)$$

$$\left(\underline{\nabla} \times - \frac{i}{c} \frac{\partial}{\partial t} \right) \underline{A}^L = \underline{0} \quad -(15)$$

The components of Eq. (14) are :

$$\frac{\partial A_z^R}{\partial y} - \frac{\partial A_y^R}{\partial z} + \frac{i}{c} \frac{\partial A_x^R}{\partial t} = 0 \quad -(16)$$

$$\frac{\partial A_x^R}{\partial z} - \frac{\partial A_z^R}{\partial x} + \frac{i}{c} \frac{\partial A_y^R}{\partial t} = 0 \quad -(17)$$

$$\frac{\partial A_y^R}{\partial x} - \frac{\partial A_x^R}{\partial y} + \frac{i}{c} \frac{\partial A_z^R}{\partial t} = 0. \quad -(18)$$

Now use the quantum condition :

$$p^\mu = i\hbar \partial^\mu \quad -(19)$$

where :

$$p^\mu = \left(\frac{E_n}{c}, \underline{p} \right), \quad \partial^\mu = \left(\frac{1}{c} \frac{\partial}{\partial t}, -\underline{\nabla} \right) \quad -(20)$$

Thus :

$$E_n = i\hbar \frac{\partial}{\partial t}, \quad \underline{p} = -i\hbar \underline{\nabla}. \quad -(21)$$

Eqs. (16) to (18) therefore become :

4)

$$\frac{E_n}{c} A_x^R + i p_y A_z^R - i p_z A_y^R = 0 \qquad -(22)$$

$$\frac{E_n}{c} A_y^R + i p_z A_x^R - i p_x A_z^R = 0 \qquad -(23)$$

$$\frac{E_n}{c} A_z^R + i p_x A_y^R - i p_y A_x^R = 0. \qquad -(24)$$

Define ~~[illegible]~~ ~~[illegible]~~ -spinor:

$$\phi^R = \begin{bmatrix} A_x^R \\ A_y^R \\ A_z^R \end{bmatrix} \qquad -(25)$$

and:

$$\underline{\alpha} \cdot \underline{p} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -i \\ 0 & i & 0 \end{bmatrix} p_x + \begin{bmatrix} 0 & 0 & i \\ 0 & 0 & 0 \\ -i & 0 & 0 \end{bmatrix} p_y + \begin{bmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} p_z \qquad -(26)$$

$$= i \begin{bmatrix} 0 & -p_z & p_y \\ p_z & 0 & -p_x \\ -p_y & p_x & 0 \end{bmatrix}.$$

Then Eqs (22) to (24) are:

$$\left(\frac{E_n}{c} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + i \begin{bmatrix} 0 & -p_z & p_y \\ p_z & 0 & -p_x \\ -p_y & p_x & 0 \end{bmatrix} \right) \begin{bmatrix} A_x^R \\ A_y^R \\ A_z^R \end{bmatrix} = 0$$

or

$$\left(\frac{E_n}{c} + \underline{\alpha} \cdot \underline{p} \right) \phi^R = 0 \qquad -(27) \quad -(27a)$$

Similarly:

$$\left(\frac{E_n}{c} - \underline{\alpha} \cdot \underline{p} \right) \phi^L = 0 \qquad -(28)$$

5) Eqs (27) and (28) are Weyl equations, i.e. Dirac equations with no mass term. Instead of the Pauli matrices, the rotation matrices of eq. (26) are used. Eqs (27) and (28) are limits of:

$$\left(\Box + \left(\frac{mc}{\hbar} \right)^2 \right) \psi = 0 \quad -(29)$$

when $m \to 0$. Here:

$$\psi = \begin{bmatrix} \phi^R \\ \phi^L \end{bmatrix}, \quad -(30)$$

a six-spinor analogous to the Dirac four spinor. Eq. (29) is a limit of the Evans wave equation:

$$(\Box + kT)\psi = 0 \quad -(31)$$

The spinor ψ is obtained from the tetrad:

$$q_\mu^a = \begin{bmatrix} A_1^R & A_2^R & A_3^R \\ A_1^L & A_2^L & A_3^L \end{bmatrix} \quad -(32)$$

defined by:

$$A^{(0)} \begin{bmatrix} A^R \\ A^L \end{bmatrix} = \begin{bmatrix} A_1^R & A_2^R & A_3^R \\ A_1^L & A_2^L & A_3^L \end{bmatrix} \begin{bmatrix} A^1 \\ A^2 \\ A^3 \end{bmatrix} \quad -(33)$$

This illustration shows that the MH

6) electromagnetism of the standard model is an example of a spin equation which is the massless special relativistic limit of the Evans wave equation. The symmetry in this case can be either O(3) or SU(3). Finally the Weinberg equation is the spin equation for any integral or half-integral spin.

All spin equations of physics can therefore be obtained from the Evans wave equation. The spinor in general is n dimensional.