224(4): Pfeiffer's Criticism of the Standard Model.

This criticism has been known since 1939, when Wigner developed his little group method. Consider a massless particle moving along the Z axis, then:

$$k^\mu = (k, 0, 0, k) \quad -(1)$$

As shown in Ryder, pp. 63 ff, the most general Lorentz transformation that leaves k invariant is:

$$\begin{aligned} U &= 1 + i\theta J_3 + iu(K_1 - J_2) + iv(K_2 + J_1) \\ &= 1 + i\theta J_3 + iuL_1 + ivL_2 \quad -(2) \end{aligned}$$

The generators form a Lie algebra which is:

$$[L_1, L_2] = 0 \quad -(3)$$

$$[J_3, L_1] = iL_2 \quad -(4)$$

$$[L_2, J_3] = iL_1 \quad -(5)$$

The problem is that this is the Euclidean group $E(2)$, which is the group of rotations generated by J_3 and translations L_1 in a plane: the Euclidean group $E(2)$. This group makes no sense in physics. This group leads to the conclusion that a massless particle is characterised by helicity λ and $-\lambda$,

2) leads to the conclusion that the massless photon can only be left or right circularly polarized.

This conclusion has been strongly contested for many years. The problem is most easily seen in the inverse Faraday effect, which is described by the $\underline{B}^{(3)}$ field defined by:

$$\underline{B}^{(3)} = -ig\,\underline{A}^{(1)} \times \underline{A}^{(2)} \quad -(6)$$

Here, the conjugate product $\underline{A}^{(1)} \times \underline{A}^{(2)}$ is observed in the inverse Faraday effect, and is defined as the cross product of the the transverse part of the electromagnetic potential:

$$\underline{A}^{(1)} = \frac{A^{(0)}}{\sqrt{2}}\left(\underline{i} + i\underline{j}\right)e^{i\phi} \quad -(7)$$

$$\underline{A}^{(2)} = \frac{A^{(0)}}{\sqrt{2}}\left(\underline{i} - i\underline{j}\right)e^{-i\phi} \quad -(8)$$

where ϕ is the electromagnetic phase.

Elementary vector analysis means that $\underline{A}^{(1)} \times \underline{A}^{(2)}$ produces the longitudinal $\underline{B}^{(3)}$ field, which means that the photon has mass.

3) Therefore the entire theory of the Higgs boson collapses because of the inverse Faraday effect.

If attempts are made to quantize the electromagnetic field A^μ they result in four degrees of polarization, two of which have to be removed by the Gupta Bleuler condition. This arbitrarily removes the timelike and longitudinal states, and is a nonsensical procedure.

The existence of photon mass means that the Proca equations are used at the U(1) level:

$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu, \quad -(9)$$

$$\partial_\mu F^{\mu\nu} + m^2 A^\nu = 0, \quad -(10)$$

$$\partial_\mu A^\mu = 0 \quad -(11)$$

where m is the photon mass, with the Lagrangian:

$$\mathcal{L} = -\frac{1}{4} F^{\mu\nu} F_{\mu\nu} + \frac{1}{2} m^2 A_\mu A^\mu \quad -(12)$$

and this leads to three states of polarization.
