Unify Electromagnetic and Weak Interactions

1. It was suggested by Schwinger (1956)
   Glashow (1958) ph.D Thesis

   and was succeeded by

   S. Weinberg, PRL 19 (1967)
   A. Salam, Proc. of the 8th Nobel Symp. on Elementary Particle Theory, (1968)

Note
① "Renormalizability" was not yet proven by 't Hooft (1972)
② quarks were not included in Weinberg's paper.

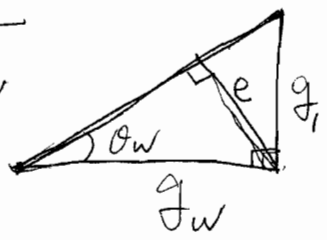
2. Weinberg introduced $SU(2) \times U(1)$
   $\Rightarrow$ require Z^0-boson (with mass M_Z)
   and Weak mixing angle $\sin\theta_W$
   (or Weinberg's angle)

Predicted:

① $M_Z^2 = \dfrac{M_W^2}{\cos^2\theta_W}$

② $\sin\theta_W = \dfrac{e}{g_W}$

$\cos\theta_W = \dfrac{e}{g_1}$



$SU(2) \times U(1)$
↑ ↑
g_W g_1

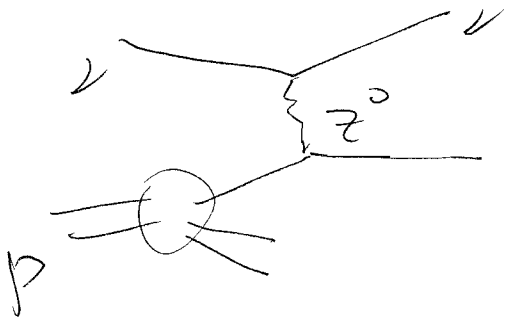
$\left(\dfrac{1}{e^2} = \dfrac{1}{g_W^2} + \dfrac{1}{g_1^2}\right)$

3. To test $SU(2) \times U(1)$, it is needed to do

$\nu + p \longrightarrow \nu + p$

$\bar{\nu} + p \longrightarrow \bar{\nu} + p$

via Z^0 - boson



(Neutrino DIS exp.)

$\Rightarrow \sin\theta_W$ was measured.

(1)

(2) QCD parton model was confirmed (quarks ⊕ gluons)

Fermion Mass

$$\mathcal{L}_e = Y_e \cdot \left(\bar{R}\, \bar{\phi}_0\, L + \bar{L}\, \phi_0\, R \right)$$

- Y_e: Yukawa coupling
- L: left-handed fermions
- R: right-handed fermion
- ϕ_0: Higgs doublet

$$\Rightarrow \boxed{m_e = \frac{Y_e \cdot v}{\sqrt{2}}}$$

depends on the unknown Y_e

$\Rightarrow$ m_e can not be predicted by the model.