Electro-Strong interaction

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Here, I will propose electro-strong interaction to solve the problem of gluon mass based on standard model.

Based on Yang-Mills standard model:

\[ F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu - [A_\mu, A_\nu] \]

QHD formula is:

\[ U(SU(2)) = \exp \left[ ig \sum_{j=1}^{8} F_j G_j(x) \right] \]

Thus:

\[ \partial^\mu = \partial^\mu + igF \times G(x) \]

Besides, \( F = \frac{1}{2\lambda} \), \( \lambda \) is GelMann matrix

\[ \lambda_1 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \]

\[ \lambda_2 = \begin{bmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \]

\[ \lambda_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \]

\[ \lambda_4 = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix} \]

\[ \lambda_5 = \begin{bmatrix} 0 & 0 & -i \\ 0 & 0 & 0 \\ i & 0 & 0 \end{bmatrix} \]
For Photon, there is an additional matrix:

\[
\lambda_8 = \frac{1}{\sqrt{3}} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -2 \end{bmatrix}
\]

Besides every matrix has the corresponding gluon or photon:

\[
\lambda_9 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}
\]

We let \( R \) or \( R^\ast = (1,0,0) \), \( B \) or \( B^\ast = (0,1,0) \), and \( G \) or \( G^\ast = (0,0,1) \). Then, the whole matrix is:

\[
\begin{bmatrix}
    rR & bR & gR \\
    rB & bB & gB \\
    rG & bG & gG 
\end{bmatrix}
\]

Besides, every matrix has the corresponding gluon or photon:

\[
G_1 = \frac{1}{\sqrt{2}} (r\bar{b} + b\bar{r})
\]

\[
G_2 = \frac{i}{\sqrt{2}} (r\bar{b} - b\bar{r})
\]

\[
G_3 = \frac{1}{\sqrt{2}} (r\bar{R} - b\bar{B})
\]

\[
G_4 = \frac{1}{\sqrt{2}} (r\bar{g} + g\bar{r})
\]

\[
G_5 = \frac{i}{\sqrt{2}} (r\bar{g} - g\bar{r})
\]

\[
G_6 = \frac{1}{\sqrt{2}} (g\bar{b} + b\bar{g})
\]
\[ G_7 = \frac{1}{\sqrt{2}} (b \bar{g} - g \bar{b}) \]
\[ G_8 = \frac{1}{\sqrt{6}} (r \bar{r} + b \bar{b} - 2g \bar{g}) \]

Besides, photon boson is:

\[ B = G_9 = \frac{1}{\sqrt{3}} (r \bar{r} + b \bar{b} + g \bar{g}) \]

Thus, there are nine bosons (8 gluons and 1 photon) as a whole 3x3 matrix to interact with Higgs bosons. We will use a complex scaler field for the Higgs boson. The Higgs field is:

\[ \varphi(x) \equiv \frac{1}{\sqrt{2}} \begin{pmatrix} \varphi_1 + i\varphi_2 \\ \varphi_3 + i\varphi_4 \\ \varphi_5 + i\varphi_6 \end{pmatrix} \]

And, \( \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_6 = 0 \) and \( \varphi_5 = \nu \)

Then, the Higgs represents as \( (0,0,\nu/\sqrt{2}) \)

Langragian is:

\[ L_\nu(\varphi) = (\partial^\mu \varphi)(\partial^\nu \varphi) - \mu^2 (\varphi(x))^2 - \lambda (\varphi(x))^4 \]

Then

\[ \frac{1}{4} \left| \left( iG_4 G(x) \right) \ast \varphi(x) \right|^2 + \left| \left( iG_5 G(x) \right) \ast \varphi(x) \right|^2 = \]

\[ \frac{1}{8} \left( \frac{1}{\sqrt{2}} g \nu (G_4 - iG_5), \frac{1}{\sqrt{2}} g \nu (G_6 - iG_7), \nu \left( \frac{1}{\sqrt{3}} k B - \frac{\sqrt{2}}{3} g G_8 \right) \right) \]

\[ \times \left( \frac{1}{\sqrt{2}} g \nu (G_4 + iG_5), \frac{1}{\sqrt{2}} g \nu (G_6 + iG_7), \nu \left( \frac{1}{\sqrt{3}} k B - \frac{\sqrt{2}}{3} g G_8 \right) \right) \]

We set \( G^4 = 1/\sqrt{2} (G_4 + iG_5) \), \( G^5 = 1/\sqrt{2} (G_4 - iG_5) \) and we get \( G^6 \) and \( G^7 \).

We let \( \sqrt{2}/\sqrt{3} g = g'' \) and \( 1/\sqrt{3} k = g' \). Then, we will get:
\( G^{8u} = \frac{(g'B^u - g''G^u_8)}{\sqrt{g'^2 + g''^2}} \) and

\( A^8 = \frac{(g'G^u_8 + g''B^u)}{\sqrt{g'^2 + g''^2}} \)

Like electro-weak theory, we get \( G^8 \) mass:

\[
m_{G^8} = \frac{\nu \sqrt{g'^2 + g''^2}}{\sqrt{2}}
\]

We get \( G^8 \) field and photon:

\[
G^8 = \frac{g'}{\sqrt{g'^2 + g''^2}} B - \frac{g''}{\sqrt{g'^2 + g''^2}} G_8 = B \sin \theta - G_8 \cos \theta
\]

\[
A = \frac{g'}{\sqrt{g'^2 + g''^2}} G_8 + \frac{g''}{\sqrt{g'^2 + g''^2}} B = G_8 \sin \theta + B \cos \theta
\]

Besides, the new gluon mass for \( G^1 \cdot G^2 \) and \( G^3 \) is still zero. Because mass term is \( 1/2M^2 \nu_u \), gluon mass for \( G^4 \cdot G^5 \cdot G^6 \) and \( G^7 \) is \( 1/2\nu g(\nu/2) \). Because of symmetry breaking, \( G^8 \) mass term is \( 1/4M^2G_{8u}G_{8u} \) and \( G^8 \) gluon becomes \( gg(\nu/\sqrt{2}) \). And,

\[
\frac{1}{\sqrt{2}} (G_1 - iG_2) = r \bar{r}, \quad \frac{1}{\sqrt{2}} (G_1 + iG_2) = b \bar{b}
\]

Thus, we get eight new gluons: \( RB, BR, RR/BB, BG, GB, GR, RG \) and \( GG \). And, \( RR/BB \) is:

\[
\frac{1}{\sqrt{2}} (r \bar{r} - b \bar{b})
\]

If \( \alpha \)-ratio is 1, we will get

\[
\sin \theta = \frac{1}{\sqrt{3}}
\]
Thus, \[
\cos \theta = \frac{\sqrt{2}}{\sqrt{3}}
\]

This equation solves the problem of Yang-Mills mass gap. That is the reason why neutron or proton is heavier than inside quarks. Via electro-strong interaction, we get five green-color related massive gluons \( G^{4,8} \): \( g_b, g_b, g_r, g_r, \) and \( g_g \). Besides, we have non-massive bosons: \( \lambda_1, \lambda_2, \lambda_3, \) & \( A \). The later four gluons can interact with Higgs boson \( 0, V/\sqrt{2} \) and get \( v/2 \) mass of \( rb \) and \( br \) as well as \( v/\sqrt{2} \) mass of \( bb \), and non-massive \( rb \). Finally, we get eight massive gluons to mediate short-distance strong force. Thus, we united electromagnetism and strong force.