QUARK/GLUON MODEL

Set up Euler intra equations for the quark spinor $\psi$ and the gluon spinor $\Phi_g$:

\[(0 + i\kappa) \psi = 0 \quad - (1)\]

and

\[(0 + i\kappa) \Phi_g = 0 \quad - (2)\]

The spinor $\psi$ may contain up to six components, $u, d, s, c, t, \text{and} b$, and the spinor $\Phi_g$ three components $\rho, \omega, \text{and} \phi_0$. In contrast to the standard model, the gluon field is massive, so $\Phi_g \neq 0$ in Eq. (2) is not zero. It is also assumed that the observed quark masses are the result of interaction between the mater field $\psi$ and the radiation field $\Phi_g$. In the free state each quark $u, d, s, c, t, \text{and} b$ has exactly the same mass, so the SU(3) symmetry of $\psi$ is exact. However, the quark/gluon interaction is strong, so the different mass of $u, d, s, c, t, \text{and} b$ are due to different types of interaction with the gluon field $\Phi_g$. Apparent confinement is due to very strong attraction.
2) Now factorize eqns. (1) and (2) into Dirac type:

\[
(i \gamma^a - m_q c \gamma^0) \psi_q = 0 \quad - (3)
\]
\[
(i \gamma^a - m_g c \gamma^0) \psi_g = 0 \quad - (4)
\]

Here \( m_q \) is the mass of the free quark, \( m_g \) is the mass of the gluon. In the standard model, the mass of the gluon is zero, but in QCD relativistic gluon mass is not allowed. The interaction between quark and gluon is given by:

\[
(i \gamma^a (\gamma^0 c a - i g S_a) - m_q c) \psi_q = 0 \quad - (5)
\]
\[
(i \gamma^a (\gamma^0 c a + i g S_a) - m_g c) \psi_g = 0 \quad - (6)
\]

Here \( g \) is a coupling parameter analogous to charge \( e \) in electrodynamics, and \( S_a \) is the change \( A_a \) in potential, analogous to \( A_a \) in electrodynamics.

The different observed quark masses are due to different coupling parameters \( g \).

From eqns. (5) the result is obtained:
\[ k^2 = \left( \frac{m_c}{E} \right)^2 + g^2 \frac{m_c}{4} \left( \frac{1}{C^2} \left( S_a + S_{a^*} \right) \right) \]
\[ + \frac{3}{2} \left( S_{a^*} S_a \right) \]

and since \( \left( S_{a^*} S_a \right) \) is different for each quark, we obtain different quark masses as observed:

\[ k^2 = \left( \frac{m_c}{E} \right)^2 \text{effective} \]

\[ = \text{L.H.S. of Eq. (7)}. \]

More generally, there is also a gravitational interaction between quarks, which is described by \( k^2 \) in Eq. (7).

So this is a simple way of seeing the quark model with the unified field theory, using exact \( SU(2) \) symmetry for \( EF \) and an exact \( SU(3) \) symmetry for \( EF^g \).
In more detail:

\[
\begin{bmatrix}
\mathbb{1} + \beta T \\
ud s
\end{bmatrix}
\begin{bmatrix}
u \\
\bar{d}
\end{bmatrix}
= 0 \quad - (1a)
\]

\[
\begin{bmatrix}
\mathbb{1} + \beta T \\
wb
\end{bmatrix}
\begin{bmatrix}
w \\
b
\end{bmatrix}
= 0 \quad - (2a)
\]

So the interaction between \(u\) and \(d\) for example is mediated by gluons whose coupling parameter \(\beta\) results in an observed mass for \(u\) that is different from the observed mass for \(d\). In the free state the masses of \(u\) and \(d\) are exactly the same, so the spin-\(1/2\) case (1a) can be set up exactly.

In general the quark/gluon interaction is very complicated, resulting in observed quark masses and elementary particle masses. It is not surprising that the quark model appears to be so many elementary particles.