$\frac{1}{\sqrt{2}} + \sqrt{2} = \frac{1+2}{\sqrt{2}} = \frac{3}{\sqrt{2}}$ 20

$(n+\rho_1 p)\frac{1-\rho_3}{2}\vec{\sigma}.\vec{a}$ $\quad -\frac{1}{2}\vec{\sigma}.\vec{a}\frac{1-\varepsilon}{2}\frac{1+\rho_3}{2}(-n+\rho_1 p) = \begin{pmatrix} 0 & 0 & -n\frac{a^+}{\sqrt{2}} & p\frac{a^+}{\sqrt{2}} \\ 0 & 0 & n\frac{a_0}{2} & -p\frac{a_0}{2} \\ 0 & 0 & n\frac{a_0}{2} & -p\frac{a_0}{2} \\ 0 & 0 & n\frac{a^-}{\sqrt{2}} & -p\frac{a^-}{\sqrt{2}} \end{pmatrix} + \frac{1+\varepsilon}{2}\begin{pmatrix} 0 & 0 & p a_0 & \sqrt{2}a^+ p \\ 0 & 0 & p\sqrt{2}a^- & -p a_0 \\ 0 & 0 & n a_0 & \sqrt{2}n a^+ \\ 0 & 0 & \sqrt{2}n a^- & -n a_0 \end{pmatrix}$

$-n a_0 - p$

$\frac{1+\varepsilon}{2}$ $\qquad n\frac{a_0}{2} + p\sqrt{2}a^-$

$\frac{3}{2}n a_0$

$\frac{2 n a_0 + p\sqrt{2}a^-}{2} = n a_0 + \frac{p a^-}{\sqrt{2}}$

$T^{\frac{3}{2}} = \frac{1+\varepsilon}{2}\vec{\sigma}.\vec{a}\,(n+\rho_1 p)\frac{1-\rho_3}{2} + \frac{1+\varepsilon}{2}\vec{\sigma}.\vec{a}\frac{1-\varepsilon}{2}(n+\rho_1 p)\frac{1-\rho_3}{2}$

$= \underbrace{\frac{1+\varepsilon}{2}\vec{\sigma}.\vec{a}\left(1+\frac{1-\varepsilon}{2}\right)}_{\text{same as } (\vec{\sigma} + \frac{i}{2}\vec{\rho}\times\vec{\sigma})\,.\,\vec{a}}(n+\rho_1 p)\frac{1-\rho_3}{2} = \frac{1+\varepsilon}{2}\vec{\sigma}.\vec{a}\left(\frac{3-\varepsilon}{2}\right)(n+\rho_1 p)\frac{1-\rho_3}{2}$

$(n+\rho_1 p)\frac{1-\rho_3}{2}$

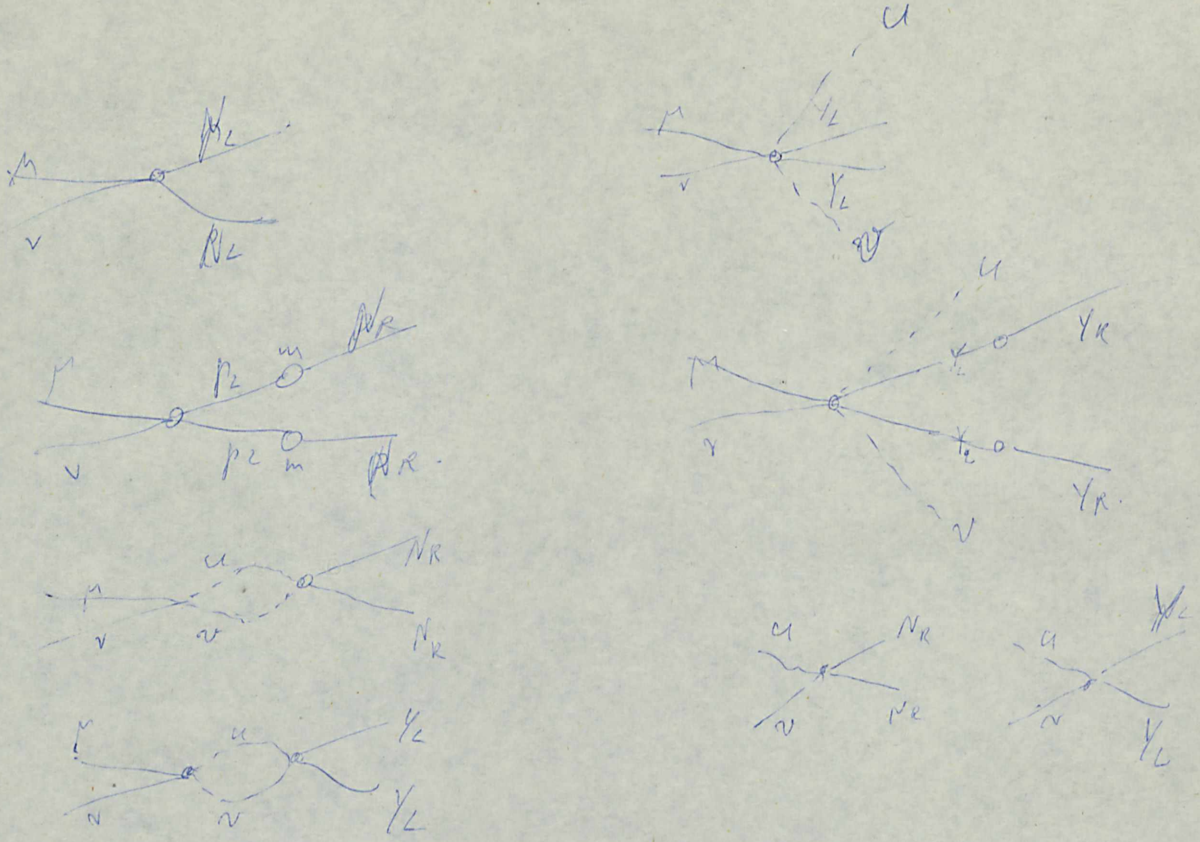
$\sqrt{2}\frac{a^-}{2} - \frac{a_0}{2} - a$

$\sqrt{2} + \frac{1}{\sqrt{2}} = \frac{3}{\sqrt{2}}$

$\frac{1-\varepsilon}{2} = \begin{pmatrix} 0 & & & \\ & \frac{1}{2} & -\frac{1}{2} & \\ & -\frac{1}{2} & \frac{1}{2} & \\ & & & 0 \end{pmatrix}$

$\frac{1+\varepsilon}{2}\begin{pmatrix} a_0 & \sqrt{2}a^+ & & \\ \sqrt{2}a^- & -a_0 & & \\ & & a_0 & \sqrt{2}a^+ \\ & & \sqrt{2}a^- & -a_0 \end{pmatrix} + \frac{1+\varepsilon}{2}\begin{pmatrix} a_0 & \sqrt{2}a^+ & & \\ \sqrt{2}a^- & -a_0 & & \\ & & a_0 & \sqrt{2}a^+ \\ & & \sqrt{2}a^- & -a_0 \end{pmatrix}\frac{1-\varepsilon}{2}$

$= \begin{pmatrix} a_0 & \sqrt{2}a^+ & 0 & 0 \\ \frac{a^-}{\sqrt{2}} & -\frac{a_0}{2} & \frac{a_0}{2} & \frac{a^+}{\sqrt{2}} \\ \frac{a^-}{\sqrt{2}} & -\frac{a_0}{2} & \frac{a_0}{2} & \frac{a^+}{\sqrt{2}} \\ 0 & 0 & \sqrt{2}a^- & a_0 \end{pmatrix} + \frac{\varepsilon}{2}\begin{pmatrix} 0 & \frac{a^+}{\sqrt{2}} & -\frac{a^+}{\sqrt{2}} & 0 \\ 0 & -\frac{a_0}{2} & \frac{a_0}{2} & 0 \\ 0 & -\frac{a_0}{2} & \frac{a_0}{2} & 0 \\ 0 & -\frac{a^-}{\sqrt{2}} & \frac{a^-}{\sqrt{2}} & 0 \end{pmatrix} = \begin{pmatrix} a_0 & \frac{3}{\sqrt{2}}a^+ & -\frac{a^+}{\sqrt{2}} & 0 \\ \frac{a^-}{\sqrt{2}} & -a_0 & a_0 & \frac{a^+}{\sqrt{2}} \\ \frac{a^-}{\sqrt{2}} & -a_0 & a_0 & \frac{a^+}{\sqrt{2}} \\ 0 & -\frac{a^-}{\sqrt{2}} & \frac{3}{\sqrt{2}}a^- & -a_0 \end{pmatrix}$



μ
ν
μL
νL
μL
m
NR
pL
m
NR
u
ν
NR
NR
YL
YL
u
YL
YL
ν
u
YL
YR
YL
YR
u
NR
NR
u
YL
YL

$\cancel{x}'\ X$

FGA.SCI.04.006.08.0C.02

Spin 2 has the form $\frac{i}{2}(\rho_m\sigma_n+\rho_n\sigma_m)-\frac{1}{3}\vec{\rho}\cdot\vec{\sigma}$ (5)

Spin 1 can be formed out of $\vec{\rho}$, $\vec{\sigma}$ and $\vec{\rho}\times\vec{\sigma}$

Take the combination $\frac{1+\varepsilon}{2}\,\vec{\sigma}\,\frac{3-\varepsilon}{2}$ (3) $=\vec{\rho}+\vec{\sigma}+i\,\vec{\rho}\times\vec{\sigma}$.

adding the two we can form general spin $\frac{3}{2}$. (8 real or 4 complex)

$\rho_1\sigma_2+\rho_2\sigma_m$

$\varepsilon=\frac{1+\vec{\rho}\cdot\vec{\sigma}}{2}$

$1-\varepsilon=\frac{1-\rho\cdot\sigma}{2}$

$1-\frac{1}{2}+\rho\sigma$

$3\rho\,\rho\cdot\sigma=3\sigma+3i\,\rho\times\sigma$

$-\sigma\,\rho\cdot\sigma=-\rho+i\rho\times\sigma$

$(3\rho-\sigma)\rho\cdot\sigma=3\sigma-\rho+4i\rho\times\sigma$

$$\left(\sigma_p+\frac{i}{2}\rho_m\frac{\sigma_n-\rho_n\sigma_m}{2}\right)\rho_p$$

$\varepsilon=\frac{1+\rho\cdot\sigma}{2}$

$(1+\varepsilon)(3\sigma-\sigma\varepsilon)=3\sigma-\sigma\varepsilon+3\sigma\varepsilon-\rho$

$=(3\sigma-\rho)+(3\rho-\sigma)\varepsilon$

$=3\sigma-\rho+(3\rho-\sigma)\left(\frac{1+\rho\cdot\sigma}{2}\right)=3\sigma-\rho+\frac{3\rho-\sigma}{2}+\frac{1}{2}(3\rho-\sigma)\rho\cdot\sigma$

$=\frac{3\sigma-\rho}{2}+\frac{3\sigma-\rho+4i\rho\times\sigma}{2}$

$=2\sigma+2\rho+2i\rho\times\sigma=2[\rho+\sigma+i\rho\times\sigma]$

$\frac{1+\varepsilon}{2}=\frac{3+\vec{\rho}\cdot\vec{\sigma}}{4}$ $\qquad\frac{1-\varepsilon}{2}=\frac{1-\vec{\rho}\cdot\vec{\sigma}}{4}$

$$U=\frac{1+\varepsilon}{2}\left(\frac{3\vec{\sigma}-\vec{\rho}}{2}\cdot\vec{a}\right)$$

$\omega=\frac{1-\varepsilon}{2}+\frac{1+\varepsilon}{\sqrt{2}}=\frac{1-\rho\cdot\sigma}{4}+\frac{\sqrt{2}(3+\rho\cdot\sigma)}{4}=\frac{3\sqrt{2}+1+(\sqrt{2}-1)\rho\cdot\sigma}{4}$

$$U=\frac{1+\varepsilon}{2}\,\vec{\sigma}\cdot\vec{a}\left(1-\frac{\varepsilon}{2}+\frac{1+\varepsilon}{\sqrt{2}}\right)=\frac{1+\varepsilon}{2}\,\vec{\sigma}\cdot\vec{a}\left(\frac{1-\varepsilon+\sqrt{2}(1+\varepsilon)}{2}\right)=\frac{1+\varepsilon}{2}\,\vec{\sigma}\,2\,\frac{(1+\sqrt{2})+(\sqrt{2}-1)\varepsilon}{2}$$

wrong.

$(\rho_1\sigma_1+\rho_2\sigma_2+\rho_3\sigma_3)\sigma_1=\rho_1+i(\rho_3\sigma_2-\rho_2\sigma_3)$

$\vec{\sigma}\cdot(\vec{\rho}\cdot\vec{\sigma})=\vec{\rho}-i(\vec{\rho}\times\vec{\sigma})$

$\vec{\rho}\,(\vec{\rho}\cdot\vec{\sigma})=\vec{\sigma}+i(\vec{\rho}\times\vec{\sigma})$

$(\vec{\rho}\cdot\vec{\sigma})\,\vec{\sigma}=\vec{\rho}+i(\vec{\rho}\times\vec{\sigma})$

$(\rho\cdot\sigma)\cdot\vec{\rho}=\vec{\sigma}-i(\vec{\rho}\times\vec{\sigma})$

$\frac{1+\varepsilon}{2}\,\sigma\cdot a\quad\frac{3+\rho\cdot\sigma}{4}\,\sigma\cdot a=\frac{3\,\sigma\cdot a+(\rho\cdot\sigma)\,\sigma\cdot a}{4}$

$=\frac{3\sigma\cdot a+\rho\cdot a-i(\rho\times\sigma)\cdot a}{4}$ $\qquad(\lambda+\vec{\rho}\cdot\vec{\sigma}\,\mu)$

$-\rho_2\rho_3\sigma_1\sigma_3$

$\rho_2\rho_3\sigma_3\sigma_1$

$(\rho_1\times\sigma_2\ldots-\rho_1\sigma_2$

$-i\rho_2\times\sigma_1\quad-\rho_2\sigma_1$

$\rho_1\rho_3\sigma_2\sigma_3-\rho_2\rho_3\sigma_1\sigma_3$

$-\rho_1\rho_1\sigma_2\sigma_3+\rho_2\rho_3\sigma_3\sigma_1$

$-i\rho_2\times i\sigma_1\quad+i\rho_1\times i\sigma_1$

$(\rho_1\sigma_2-\rho_2\sigma_1)(\rho_1\sigma_1+\rho_2\sigma_2+\rho_3\sigma_3)=\cancel{\sigma_2\sigma_1+i\rho_3}\;2i\sigma_3+2i\rho_3+\rho_2\sigma_1-\rho_1\sigma_2$

$(\vec{\rho}\times\vec{\sigma})\cdot(\vec{\rho}\cdot\vec{\sigma})$

$(\rho-\sigma)\cdot\vec{\rho}\cdot\vec{\sigma}=(\sigma-\rho)+2i(\rho\times\sigma)$

$(\rho+\sigma)\cdot\rho\cdot\sigma=\rho+\sigma$

$$\boxed{(\vec{\rho}\times\vec{\sigma})\cdot(\vec{\rho}\cdot\vec{\sigma})=2i(\vec{\rho}-\vec{\sigma})-\vec{\rho}\times\vec{\sigma}}$$

$$\vec{\rho}\times\vec{\sigma}\,(1+\vec{\rho}\cdot\vec{\sigma})=2i(\vec{\rho}-\vec{\sigma}).$$

$\frac{1+\varepsilon}{2}\,\vec{\sigma}\cdot\vec{a}\,\frac{1-\varepsilon}{2}=\frac{1}{4}(1+\varepsilon)(\sigma\cdot a-\sigma\cdot a\varepsilon)=\frac{1}{4}(\sigma\cdot a-\sigma\cdot a\,\varepsilon+\varepsilon\,\sigma\cdot a-\varepsilon\,\sigma\cdot a\,\varepsilon)=\frac{1}{4}(\rho-\sigma)\cdot\vec{a}\,1-\varepsilon=\frac{1}{2}(\vec{\rho}-\vec{\sigma})\cdot\vec{a}\,\frac{1-\rho\cdot\sigma}{2}$

$=\frac{1}{4}(\sigma-\rho)\cdot a+(-\sigma\cdot a+\rho\cdot a)\varepsilon$

$\left[b+(\vec{\sigma}.\vec{a})\right]\frac{1-\varepsilon}{2}$

18

$\frac{1-\varepsilon}{2} = \frac{1}{2}\begin{pmatrix}1&&&\\&&&\\&&1&\\&&&1\end{pmatrix} + \frac{1}{2}\begin{pmatrix}-1&&&\\&&-1&\\&-1&&\\&&&-1\end{pmatrix} = \begin{pmatrix}0&0&0&0\\0&\frac{1}{2}&-\frac{1}{2}&0\\0&-\frac{1}{2}&\frac{1}{2}&0\\0&0&0&0\end{pmatrix}$

$$J = \begin{pmatrix} t^+ + s^+ - a^+ & t^{++} \\ t^0 - \frac{a_0}{\sqrt{2}} + \frac{ib}{2} & -t^+ + s^+ \\ t^0 + s_0 - \frac{a_0}{\sqrt{2}} + \frac{ib}{2} & -t^+ \\ t^- + a^- & -t^0 + s^0 \end{pmatrix} \quad e^{i(s\cdot\varphi + \sigma\cdot\nu)}$$

$+1 \quad +\frac{1}{2}$

$\Sigma \quad \Xi^0$

$\Sigma \quad \Xi^0$

$\Sigma \quad \Xi^0$

$t^0 - ib$

$t^0 + ib$

$-t^0$

$a^+ = u^+$

$\frac{a_0}{\sqrt{2}} + \frac{ib}{2} = v$

$\frac{v+v^*}{2} = \frac{a_0}{\sqrt{2}}$

$$J = \begin{pmatrix} t^+ + s^+ - u & t^{++} \\ t^0 - v & -t^+ + s^+ \\ t^0 + s_0 - v^* & -t^+ \\ t^- + u^* & -t^0 + s^0 \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \\ e & f \\ g & h \end{pmatrix}$$

$t = \Sigma^- \pi$ $\qquad$ $t^+ = \Sigma^+ \pi + \Sigma^0 p$

$$\begin{cases} t^0 - v = c \\ t^0 + s_0 - v^* = e \\ -t^0 + s_0 = h \end{cases}$$

$2t^0 - \frac{v^*}{2} = \frac{e-h}{2}$

$-t^0 + v = -c$

$v - \frac{v^*}{2} = \frac{e-h-2c}{2}$

$v^* - \frac{v}{2} = \frac{e^*-h^*-2c^*}{2}$

$v + v^* - \frac{v+v^*}{2} = \frac{v+v^*}{2} = 2\mathcal{R}\,\frac{e-h-2c}{2}$

$v - v^* + \frac{v-v^*}{2} = \mathcal{I}m(e-h-2c)$

$= \frac{3}{2}\,\frac{v-v^*}{2i} \cdot \mathcal{I}m = \frac{3}{2}\frac{b}{2}$

$t^0 - \frac{v}{2} = \frac{e-h}{2}$

$-t^0 + v^*$

$b = t^{++}$

$a = t^+ + s^+ - u$

$c = t^0 - v$

$d = -t^+ + s^+$

$a = t^+ + s^+ - u \qquad b = t^{++}$

$c = t^0 - v \qquad d = -t^+ + s^+$

$e = t^0 - v^* + s_0 \qquad f = -t^+$

$g = t^- + u^* \qquad h = -t^0 + s_0$

4 complex: $\quad t^+, t^0, t^-$: 3 complex

$-f+d-f$

$t^+ + s^+ - a \qquad s^+, s^0$: 2 complex

u, v : 2 complex

: 1 complex

8 complex

$\frac{4+3+2+1}{8 = 4+2+2}$

$$\boxed{\begin{array}{lll} t^{++} = b & s^+ = d + f & u = d - a - 2f = a^+ \\ t^+ = -f & s_0 = h + c + \mathcal{R}(e-h-2c) + \frac{3}{2}i\,\mathcal{I}m(\ ) & \frac{a_0}{\sqrt{2}} = \mathcal{R}(e-h-2c) \\ t^- = g - d^* - a^* - 2f^* & & b = \frac{4}{3}\mathcal{I}m(e-h-2c) \\ t^0 = c + \mathcal{R}(e-h-2c) + \frac{2i}{3}\mathcal{I}m(e-h-2c) & & \end{array}}$$

p

h

T^{++}

T^+

T^0

T^-

$T=2$

$\pi^+ K^0 + \frac{\pi^0}{\sqrt{2}} K^+$

$\pi^0 K^0$

$\begin{pmatrix} \\ \end{pmatrix} \xrightarrow{\frac{3}{2}} e^{i\frac{s+\sigma}{2}\omega}\begin{pmatrix} \\ \end{pmatrix} e^{-i\frac{\sigma}{2}\omega}$

$-\frac{\pi^+}{\sqrt{2}}K^0 + \pi^0 K^+$

$T=2$

$16 = 5 + 4$

$M = \left((a_0 + i\vec{\sigma}.\vec{a})\frac{1-\varepsilon}{2} + (s_0 + \rho_1 s^+) + T_{\frac{3}{2}}\right)\frac{1+\rho_3}{2}$

$(K\pi)\ \frac{3}{2}$

$J_\mu = \psi e^{\pi + K}$

$J = (1 + \pi + K)^2 = (1 + \pi^2 + K^2) + \pi + K + \pi K$

$0 \quad 1 \quad \frac{1}{2} \quad \frac{3}{2}$

$(1 + (\pi + K) + (\pi + K)^2$

$\frac{n_1 + in_2}{\sqrt{2}} = n^+$

φ $\quad \tau_i \varphi$

$\rho^{(+)} = \frac{\rho_1 + i\rho_2}{\sqrt{2}}$

$\left(\delta_{ij} - \frac{\tau_i \tau_j}{N}\right)\tau_i = 0$

$\frac{1+\varepsilon}{2} \quad \frac{1-\varepsilon}{2}$

$\varepsilon = \frac{1+\vec{\rho}\cdot\vec{\sigma}}{2}$

ρ^{+1}

$\varphi \quad \tau$

$\frac{\rho_1 + i\rho_2}{2} = \frac{\rho_1 + i\rho_2}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}$

$\rho^+ \frac{1-\rho\cdot\sigma}{4} = \begin{pmatrix} \sigma^+ \frac{1-\rho\cdot\sigma}{4} \\ \sigma_3 \frac{1-\rho\cdot\sigma}{4} \\ \sigma^- \frac{1-\rho\cdot\sigma}{4} \end{pmatrix}$ $\quad \begin{pmatrix} T_{11} \\ T_{10} \\ T_{1-1} \end{pmatrix} \to \vec{\sigma} \cdot \frac{1-\varepsilon}{2} = \vec{\sigma} \cdot \frac{1-\rho\cdot\sigma}{4}$

$\frac{1-\rho_3}{2}$

$T = 1 \qquad T = \frac{1}{2}$

$\boxed{\begin{matrix} T_{\frac12 \frac12} \cdot \frac{1-\rho\cdot\sigma}{2} \frac{1}{\sqrt{2}} \rho^+ = \frac{\rho_1 + i\rho_2}{2} = \rho_1 \frac{1-\rho_3}{2} \\ T_{\frac12 -\frac12} \cdot \frac{1-\rho\cdot\sigma}{2} \cdot \frac{1-\rho_3}{2} \end{matrix}}$

$J^+ \Omega = \rho^+ \Omega \quad T_{\frac12 \frac12}$

$\rho^{+2} = 0$

$T_{\frac32, \frac32} = T_{11} \times T_{\frac12 \frac12}$

$= \sigma^+ \frac{1-\rho\cdot\sigma}{4} \cdot \rho_1 \frac{1-\rho_3}{2} = \begin{pmatrix} 0 & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{pmatrix}$

$J^+ \rho^+ 1 = \frac{1-\rho_3}{2} = T_{\frac12 \frac12}$ $\quad \cancel{T_{\frac32 \frac12} = \frac{1}{\sqrt{3}}\left(\sqrt{2}\, T_{10} T_{1-\frac12} + \right.}$

$T_{\frac32 \frac12} = \frac{1}{\sqrt{3}}\left(\sqrt{2}\, T_{10} T_{\frac12 \frac12} - T_{11} T_{\frac12 -\frac12}\right) = \frac{1}{\sqrt{3}} \begin{pmatrix} 1 & 0 \\ 0 & -1 \\ 0 & -1 \\ 0 & 0 \end{pmatrix}$

$T_{\frac32 -\frac12} = \frac{1}{\sqrt{3}}\left(\sqrt{2}\, T_{10} T_{\frac12 -\frac12} + T_{11} T_{\frac12 \frac12}\right) = \frac{1}{\sqrt{3}} \begin{pmatrix} 0 & 0 \\ 1 & 0 \\ 1 & 0 \\ 0 & -1 \end{pmatrix}$

$T_{\frac32 -\frac32} = T_{1-1} \times T_{\frac12 -\frac12}$

$= \sigma^- \frac{1-\rho\cdot\sigma}{2} \rho_1 \frac{1-\rho_3}{2} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 1 & 0 \end{pmatrix}$

$\mathcal{J} =$

$\Omega = (\quad) \to e^{i\frac{\rho+\sigma}{2}\cdot\omega} \Omega e^{-\frac{i\sigma\omega}{2}} = e^{i\frac{\rho+\sigma}{2}\omega} \left(X_{1\rho} + Y_{\rho,\sigma}\right) e^{-i\frac{\sigma\omega}{2}} = e^{i\frac{\rho\omega}{2}} X_\rho + e^{i\frac{\rho+\sigma}{2}\cdot\omega} Y e^{-\frac{\sigma\omega}{2}}$ $\quad 2\times 4$

$\left(\delta_{ij} - \frac{\tau_i \tau_j}{3}\right) \sigma_j \psi$

$\tau_j \sigma_j \psi$

$\Omega_1 \to e^{i\frac{(\rho+\sigma)}{2}\cdot\omega} \Omega_1$

$\tau_i \varphi_i = 0$

$\Omega_{\frac12} \to e^{\frac{i\rho\omega}{2}} \Omega_{\frac12}$

$\varphi_i = \left(\delta_{ij} - \frac{\tau_i \tau_j}{3}\right)\psi_j$

$\left(\rho^+ a^+ + \frac{1-\rho_3}{2} a^0\right) \quad 2\times 4$

$A_\rho \quad (1-\rho_3) = (A_0 + \rho_1 A_1) \frac{1-\rho_3}{2}$

FGA-SCI-04-006.08-DC-04

$$J = \overset{1}{A} + \overset{\frac12}{S} + \overset{\frac32}{T}$$

$L_W = Tr\, J^\dagger J$ we have $Tr\, S^\dagger T = 0$.

$$Tr\, A^\dagger S = \frac{1}{2}\begin{pmatrix} 0 & 0 & 0 & 0 \\ a^- & \frac{a_0}{\sqrt2} & \frac{a_0}{\sqrt2} & -a^+ \\ -a^- & -\frac{a_0}{\sqrt2} & -\frac{a_0}{\sqrt2} & a^+ \\ 0 & 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 0 & 0 & S^+ & 0 \\ 0 & 0 & 0 & S^+ \\ 0 & 0 & S^0 & 0 \\ 0 & 0 & 0 & S^0 \end{pmatrix} = \frac{1}{2}\begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & a^-S^+ + \frac{a_0}{\sqrt2}S_0 & \frac{a_0}{\sqrt2}S^+ - a^+S^0 \\ 0 & 0 & -a^-S^+ - \frac{a_0}{\sqrt2}S^0 & -\frac{a_0}{\sqrt2}S^+ + a^+S^0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\rho = \begin{pmatrix} & \\ & \end{pmatrix} \qquad = -\left(a^- S^+ + \frac{a_0}{\sqrt2} S^0\right) = Tr\, A^\dagger S \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -a^- & -\frac{a_0}{\sqrt2} & -\frac{a_0}{\sqrt2} & a^+ \\ 0 & 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} 0 & 0 & S^+ & 0 \\ 0 & 0 & 0 & S^+ \\ 0 & 0 & S^0 & 0 \\ 0 & 0 & 0 & S^0 \end{pmatrix}$$

$$\sigma = \begin{pmatrix} \tau & \\ & \tau \end{pmatrix}$$

$\rho_3 =$

$$J = \begin{pmatrix} 0 & 0 & -a^+ & 0 \\ 6 & 0 & -\frac{a_0}{\sqrt2} & 0 \\ 0 & 0 & -\frac{a_0}{\sqrt2} & 0 \\ 0 & 0 & a^- & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & S^+ & 0 \\ 0 & 0 & 0 & S^+ \\ 0 & 0 & S^0 & 0 \\ 0 & 0 & 0 & S^0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & t^+ & t^{++} \\ 0 & 0 & t^0 & -t^+ \\ 0 & 0 & t^0 & -t^+ \\ 0 & 0 & t^- & -t^0 \end{pmatrix}$$

$(2\times2) = a_0 + \vec\sigma\cdot\vec a$ $\qquad \begin{pmatrix} a_0 & a \\ a^+ & -a_0 \end{pmatrix}$

$T=0$: $(\vec\rho, \vec\sigma)$ $\qquad$ $T=1$: $\begin{pmatrix} \vec\rho = \vec\tau \times 1 \\ \vec\sigma = 1\times\vec\tau \end{pmatrix}$

$L = Tr\, J^\dagger J$. has a $T=0$ and $\begin{pmatrix} T = +\frac12 \\ T_3 = -\frac12 \end{pmatrix}$ part.

$U = 2\times 4$ matrix $= \begin{pmatrix} 0 & 0 & a & b \\ 0 & 0 & c & d \\ 0 & 0 & e & f \\ 0 & 0 & g & h \end{pmatrix} = \begin{pmatrix} a_1 & a_3 \\ a_2 & -a_1 \\ a_2 & -a_1 \\ a_0 & -a_2 \end{pmatrix} +$

$$\begin{pmatrix} a^+ \\ a^0 \\ a^- \end{pmatrix} \qquad \begin{pmatrix} b^+ \\ b^0 \end{pmatrix}$$

$a \qquad b$

$T=1,\ T=\frac12$

$$U = \alpha_0 U_0 + \alpha_1 U_1 + \alpha_{\frac12} U_{\frac12} + \alpha_{\frac32} U_{\frac32}$$

$T=3$

$\rho^+\sigma^+,\ J^+(\rho^+\sigma^+)\ J^+{}^2(\rho^+\sigma^+), J^3(\rho^+\sigma^+)$

$T = \frac32$: $\left(\frac32, +\frac32\right) \to a^+ b^+$

$\left(\frac32, +\frac12\right) \to$

$$U_1 = \begin{pmatrix} a^+ & 0 \\ a_0 & 0 \\ a_0 & 0 \\ -a^- & 0 \end{pmatrix}$$

$T\cdot A = T_1 A_1 + T_2 A_2 + T_3 A_3 + T_4 A_4$

$\rho^+\sigma^+$

$(J_1 + iJ_2)^{\frac32}$ $\quad (\delta_{ij} - \gamma_i\gamma_j)$

$(J^+)^4 = 0$.

$J^+\Omega = \rho^+\Omega + [\sigma^+, \Omega]$

$\partial_\mu \vec{\pi} \cdot \vec{J}_\mu \rightarrow \frac{1}{2}, \frac{3}{2}$

Weak int. $T = \frac{1}{2}$ current $A = (\vec{\sigma}\cdot\vec{B})\frac{1-\epsilon}{2}$

$$J = A + B \rightarrow e^{i(\xi+\sigma)\cdot\frac{\omega}{2}} A + \ldots B$$

$$J^\dagger J = (A^\dagger + B^\dagger)(A+B) = A^\dagger A + B^\dagger B + B^\dagger A + A^\dagger B.$$

$$A \rightarrow e^{i(\xi+\sigma)\cdot\frac{\omega}{2}} A$$

$$B_\xi \rightarrow e^{i\xi\frac{\omega}{2}} B_\xi \qquad \cancel{B \rightarrow e^{i\sigma\frac{\omega}{2}} B} \quad B_\xi = \xi B$$

$$\cancel{B^\dagger A \rightarrow B^\dagger e^{-i\sigma\frac{\omega}{2}} e^{i\sigma\frac{\omega}{2}} e^{i\xi\frac{\omega}{2}} A} = B^\dagger e^{i\xi\frac{\omega}{2}} A = e^{i\xi\frac{\omega}{2}} B^\dagger A$$

$$B^\dagger A \rightarrow B_\xi^\dagger e^{-i\xi\frac{\omega}{2}} e^{i\sigma\frac{\omega}{2}} e^{i\xi\frac{\omega}{2}} A = e^{i\sigma\frac{\omega}{2}} B^\dagger A.$$

$$B = \begin{pmatrix} a_0 & & \bar{\Lambda}p & 0 \\ & & 0 & \bar{\Lambda}p \\ & & \bar{\Lambda}n & 0 \\ 0 & 0 & 0 & \bar{\Lambda}n \end{pmatrix} = \begin{pmatrix} 0 & 0 & b^+ & 0 \\ 0 & 0 & 0 & b^+ \\ 0 & 0 & b_0 & 0 \\ 0 & 0 & 0 & b_0 \end{pmatrix} \rightarrow e^{i\xi\frac{\omega}{2}} B \qquad C = \begin{pmatrix} 0 & 0 & c^+ & c^{++} \\ 0 & 0 & c^0 & c^+ \\ 0 & 0 & c^0 & c^+ \\ 0 & 0 & c^- & c^0 \end{pmatrix}$$

$$A = \begin{pmatrix} 0 & a^+ & -a^+ & 0 \\ 0 & \frac{a_0}{\sqrt{2}} & -\frac{a_0}{\sqrt{2}} & 0 \\ 0 & \frac{a_0}{\sqrt{2}} & -\frac{a_0}{\sqrt{2}} & 0 \\ 0 & -a^- & a^- & 0 \end{pmatrix}$$

$$\begin{array}{cccccc} & A & & S\ (\tfrac{1}{2}) & & T\ (\tfrac{3}{2}) \end{array}$$

$$J = \begin{pmatrix} 0 & a^+ & -a^+ & 0 \\ 0 & \frac{a_0}{\sqrt{2}} & -\frac{a_0}{\sqrt{2}} & 0 \\ 0 & \frac{a_0}{\sqrt{2}} & -\frac{a_0}{\sqrt{2}} & 0 \\ 0 & -a^- & a^- & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & s^+ & 0 \\ 0 & 0 & 0 & s^+ \\ 0 & 0 & s^0 & 0 \\ 0 & 0 & 0 & s^0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & t^+ & t^{++} \\ 0 & 0 & t^0 & -t^+ \\ 0 & 0 & t^0 & -t^+ \\ 0 & 0 & t^- & -t^0 \end{pmatrix}$$

$L_w = \mathrm{Tr}(J^\dagger J)$

$$(B^\dagger + C^\dagger)(B + C) = B^\dagger B + C^\dagger C + B^\dagger C + C^\dagger B.$$

$$B^\dagger \rightarrow B^\dagger e^{-i\xi\omega} \qquad B \rightarrow e^{i\xi\frac{\omega}{2}} B_\xi \qquad C \rightarrow e^{i(\xi+\sigma)\frac{\omega}{2}} C e^{-i\sigma\frac{\omega}{2}}$$

$$B^\dagger C \rightarrow B_\xi^\dagger e^{-i\xi\frac{\omega}{2}} e^{i\xi\frac{\omega}{2}} e^{i\sigma\frac{\omega}{2}} C e^{-i\sigma\frac{\omega}{2}} = B_\xi^\dagger e^{i\sigma\frac{\omega}{2}} C e^{-i\sigma\frac{\omega}{2}} = e^{i\sigma\frac{\omega}{2}} B_\xi^\dagger C e^{-i\sigma\frac{\omega}{2}} \qquad \mathrm{Tr}\, B^\dagger C = 0$$

$$S^\dagger T = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ s^- & 0 & s^0 & 0 \\ 0 & s^- & 0 & s^0 \end{pmatrix} \begin{pmatrix} 0 & 0 & t^+ & t^{++} \\ 0 & 0 & t^0 & -t^+ \\ 0 & 0 & t^0 & -t^+ \\ 0 & 0 & t^- & -t^0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & s^- t^+ + s^0 t^0 & s^- t^{++} - s^0 t^+ \\ 0 & 0 & s^- t^0 + s^0 t^- & -s^- t^+ - s^0 t^0 \end{pmatrix}$$

(37)

$$T = \frac{1}{2}$$

$$J_{\frac{1}{2}} = \frac{1+\varepsilon}{2}\, \bar\Sigma_\rho N_\rho \frac{1-\varepsilon}{2} = -\frac{1+\varepsilon}{2}\, \bar N_\sigma \Sigma_\sigma \frac{1-\varepsilon}{2}$$

$$= \frac{1+\varepsilon}{2}\left(\bar\Sigma_\rho N_\rho - \bar N_\sigma \bar\Sigma_\sigma\right)\frac{1-\varepsilon}{2}$$

$$\Pi + J_{\frac{1}{2}} + J_{\frac{3}{2}}$$

$$\frac{1+\gamma_5}{2} N = \begin{pmatrix} \frac{1+\gamma_5}{2}p & 0 \\ n & \gamma_5 p \\ \gamma_5 n & p \\ 0 & \frac{1+\gamma_5}{2} n \end{pmatrix}$$

$$\begin{pmatrix} \Sigma^0 & \sqrt2\,\Sigma^- \\ \sqrt2\,\Sigma^+ & -\Sigma^0 \end{pmatrix}\begin{pmatrix} \Xi^0 & p \\ \Xi^- & n \end{pmatrix} = \begin{pmatrix} \Sigma^0\Xi^0 + \sqrt2\,\Sigma^-\Xi^- & \Sigma^0 p + \sqrt2\,\Sigma^- n \\ \sqrt2\,\Sigma^+\Xi^0 - \Sigma^0\Xi^- & \sqrt2\,\Sigma^+ p - \Sigma^0 n \end{pmatrix}$$

$$J = \begin{pmatrix} 0 & \frac{\Pi^+}{\sqrt2} & & 0 \\ 0 & -\frac{\Pi^0}{2} & & 0 \\ 0 & -\frac{\Pi^0}{2} & & 0 \\ 0 & -\frac{\Pi^-}{\sqrt2} & & 0 \end{pmatrix} + \frac{\bar\Lambda}{2}\begin{pmatrix} 0 & p & -p & 0 \\ & \frac{\Xi^0 - n}{2} & & \\ & \frac{\Xi^0 - n}{2} & & \\ & -\Xi^- & & \end{pmatrix}$$

$$1 + O_{\frac{1}{2}} \begin{pmatrix} 0 & -\bar\Sigma^0 p + \frac{\sqrt2\,\bar\Sigma^-}{\sqrt2} n & & 0 \\ 0 & \bar\Sigma^0 \frac{\Xi^0 + n}{2} + \frac{\bar\Sigma^-}{\sqrt2}\Xi^- - \frac{\bar\Sigma^+}{\sqrt2} p & & 0 \\ 0 & & & 0 \\ 0 & \sqrt2\,\bar\Sigma^+ \Xi^0 - \bar\Sigma^0 \Xi^- & & 0 \end{pmatrix}$$

$$\frac{1}{2}\left(\gamma_5 - \frac{1}{3}\right)$$

$$\cancel{\lambda} + O_{\frac{3}{2}} \begin{pmatrix} 0 & -p\bar\Sigma^0 + \frac{\bar\Sigma^-}{\sqrt2}(n + 3\Xi^0) & & 0 \\ 0 & -(n+\Xi^0)\bar\Sigma^0 + \Xi^-\frac{\bar\Sigma^-}{\sqrt2} + p\frac{\bar\Sigma^+}{\sqrt2} & & 0 \\ 0 & & & 0 \\ 0 & -(\Xi^0 + 3n)\frac{\bar\Sigma^+}{\sqrt2} - \Xi^-\bar\Sigma^0 & & 0 \end{pmatrix}$$

$$\frac{1}{3}$$

$$\frac{1}{3} - O_{\frac{1}{2}} = \frac{1}{3} - \frac{1}{2}\left(\gamma_5 - \frac{1}{3}\right) = -\frac{1}{2}\gamma_5 + \frac{1}{6} + \frac{2}{6} = -\frac{1}{2}\gamma_5 + \frac{1}{2} = \frac{1+\gamma_5}{2}$$

$$\Sigma^+ \to n + \Pi^+$$

$$\bar\Sigma_\rho\left(\gamma_5 - \tfrac{1}{3}\right)N_\rho + \bar\Sigma_\rho\left(\xi - \tfrac{1}{3}\right)N_\rho \qquad p\,\bar\Sigma^+$$

$$\frac{\bar\Sigma^+}{\sqrt2}\left(O_{\frac{3}{2}} - O_{\frac{1}{2}}\right) p\, \Pi^0 \qquad O_{\frac32} = \frac13,\quad O_{\frac12} = \frac12\left(\gamma_5 - \frac13\right)$$

$$+ \frac{\bar\Sigma^-}{\sqrt2}\left(O_{\frac{3}{2}} + 2O_{\frac{1}{2}}\right) n\, \Pi^-$$

$$+ -\frac{\bar\Sigma^+}{\sqrt2}\left(3O_{\frac{3}{2}}\right) n\, \Pi^+$$

$$\frac{1}{3} - O_{\frac{1}{2}} = -\frac{1+\gamma_5}{2}$$

$$O_{\frac{3}{2}} + 2O_{\frac{1}{2}} = \gamma_5$$

$$2O_{\frac12} = \gamma_5 - O_{\frac32} \quad \frac13$$

$$\boxed{O_{\frac{3}{2}} = \frac{1}{3} \qquad O_{\frac{1}{2}} = \frac{1}{2}\left(\gamma_5 - \frac{1}{3}\right)}$$

$$\gamma_5 N = \begin{pmatrix} \gamma_5 p & \gamma_5 p \\ \gamma_5 n & \gamma_5 n \end{pmatrix} \qquad \rho N = \begin{pmatrix} p & 0 \\ n & 0 \\ 0 & p \\ 0 & n \end{pmatrix} \qquad \varepsilon\begin{pmatrix} p & \\ & p \\ n & \\ & n \end{pmatrix}$$

$$-\frac{b^+}{2} \quad \frac{b^+}{2} \quad a - \frac{a'}{4} \quad \frac{a-a'}{4} \quad \frac{b^-}{2}$$

$$\begin{matrix} a & 0 & b^+ & 0 \\ \frac{b^-}{2} & \frac{a}{2} & \frac{a'}{2} & \frac{b^+}{2} \\ \frac{b^-}{2} & \frac{a}{2} & \frac{a'}{2} & \frac{b^+}{2} \\ 0 & b^- & 0 & a' \end{matrix} \qquad \begin{matrix} a & 0 & b^+ & 0 \\ 0 & a & 0 & b^+ \\ b^- & 0 & a' & 0 \\ 0 & b^- & 0 & a' \end{matrix}$$

$$\epsilon f = \begin{pmatrix} \Xi^0 & 0 & p & 0 \\ \Xi^- & 0 & n & 0 \\ 0 & \Xi^0 & 0 & p \\ 0 & \Xi^- & 0 & n \end{pmatrix} \qquad \gamma_5 f = \begin{pmatrix} \gamma_5\Xi^0 & & \gamma_5 p & \\ & \gamma_5\Xi^0 & & \gamma_5 p \\ \gamma_5\Xi^- & & \gamma_5 n & \\ & \gamma_5\Xi^- & & \gamma_5 n \end{pmatrix}$$

$$\left(\frac{\epsilon+\gamma_5}{2}\right) f = \begin{pmatrix} \frac{1+\gamma_5}{2}\Xi^0 & 0 & \frac{1+\gamma_5}{2}p & 0 \\ \frac{\Xi^-}{2} & \frac{1}{2}\gamma_5\Xi^0 & \frac{n}{2} & \frac{1}{2}\gamma_5 p \\ \frac{1}{2}\gamma_5\Xi^- & \frac{1}{2}\Xi^0 & \frac{1}{2}\gamma_5 n & \frac{1}{2}p \\ 0 & \frac{1+\gamma_5}{2}\Xi^- & 0 & \frac{1+\gamma_5}{2}n \end{pmatrix}$$

$$\frac{\epsilon+\gamma_5}{2} f \frac{1-\epsilon}{2} = \frac{1}{2}\begin{pmatrix} 0 & -\frac{1+\gamma_5}{2}p \\ 0 & -\frac{n+\gamma_5\Xi^0}{2} \\ 0 & \frac{\Xi^0+\gamma_5 n}{2} \\ 0 & \frac{1+\gamma_5}{2}\Xi^- \end{pmatrix}$$

$(n_R + \Xi^0_R)$ does not enter the interaction but $\vec{B}_R$ does.

$e^{\omega}(\Xi_L \; N_L)e^{u}$

$e^{\omega'}(\Xi_R \; N_R)e^{u}$

Let $u = \omega'$ or $u = \omega$

Take

$$L_w = J^{+\dagger}J^{+} + J^{0\dagger}J^{0} + J^{-\dagger}J^{-}$$

Let $J^0 = J^0_1 + iJ^0_2$.

then $L_w = J^{+\dagger}J^{+} + J_1^{0\,2} + J_2^{0\,2} + J^{-\dagger}J^{-}$

or $L_w = \vec{J}^{\dagger}\cdot\vec{J} + \vec{J}'^{\dagger}\cdot\vec{J}'$

mediated by 2 fields $\vec{W}$ and $\vec{u}$

$$L = \vec{J}_\mu\cdot\vec{W}_\mu + \vec{J}'_\mu\cdot\vec{u}_\mu + \text{h.con}$$

$N_L \to e^{\omega}N_L e^{iu}$

$N_R \to e^{\omega'}N_R e^{iu}$

$\Xi_L \to e^{\omega}\Xi_L e^{-iu}$

$\Xi_R \to e^{\omega'}\Xi_R e^{-iu}$

$(\Lambda_L + \Sigma_L)_0 \to e^{\omega}(\Lambda_L+\Sigma_L)e^{\omega'}$

$\Sigma_L \cdot e^{\omega}\vec{\Sigma}_R e^{-\omega}$ $\quad \Lambda_R \to \Lambda_R$.

$\vec{K} \to e^{\omega}\vec{K}e^{-\omega}$

$\vec{J} - Y$

$J^- W^+ + J^+ W^- + J^0 W^0 + J^{0\prime} u^0 + J^{-\prime} u^+ + J^{+\prime} u^-$

$(J^0 + iJ^{0\prime})(W^0 - iu^0) + (J^0 - iJ^{0\prime})(W^0 + iu^0)$.

$u = \omega'$

$(\Lambda_L^- + \Sigma_L)\; N_L + \ldots$

FGA.SCI.04.006.08-DC-08

$$\left[\frac{1+\varepsilon}{3}(1-\theta)+\frac{1+\varepsilon}{3}\left(\frac{1}{2}+\theta\right)\right]\frac{1+\varepsilon}{2}U - \frac{1+\varepsilon}{2}U$$

$$U = \frac{1-\varepsilon}{2}U + \frac{1+\varepsilon}{2}U = 1+\varepsilon$$

$$\frac{2}{3}P_+ Q_- + \frac{1}{3}P_+ ($$

$$U = \frac{1-\varepsilon}{2}U + \frac{1+\varepsilon}{2}U = \frac{1-\varepsilon}{2}U + \frac{4}{3}\frac{1+\varepsilon}{2}\frac{1-\theta}{2}\frac{1+\varepsilon}{2}U + \frac{1}{3}\frac{1+\varepsilon}{2}(1+2\theta)\frac{1+\varepsilon}{2}U$$

$$= \frac{1-\varepsilon}{2}U + \frac{2}{3}\frac{1+\varepsilon}{2}(1-\theta)\frac{1+\varepsilon}{2}U + \frac{1}{3}\frac{1+\varepsilon}{2}(1+2\theta)\frac{1+\varepsilon}{2}U$$

$$\frac{1-\varepsilon}{2}U = R$$

$$\frac{1+\varepsilon}{2}\frac{1-\theta}{2}\frac{1+\varepsilon}{2}U = S$$

$$U = R + \frac{4}{3}S + T^{\left(\frac{3}{2}\right)}$$

$\cancel{1+(1-\theta)=}$

$-1-(1-\theta)=$

$-2-$

$\frac{1}{2}(1+\frac{1}{3})$

$3+x$

$$2-2\theta = \frac{3}{2}+\left(\frac{1}{2}-2\theta\right)$$

$$\frac{1+2\theta}{3} = \frac{3}{2}-\frac{1}{2}+2\theta$$

$$\frac{1}{3}\frac{1+\varepsilon}{2}(2-2\theta)+\frac{1}{3}\frac{1+\varepsilon}{2}(1+2\theta)$$

$$\left(\frac{3}{2}+x\right)\left(\frac{3}{2}-x\right)$$

$$\frac{1}{2}+\frac{1}{6}=\frac{3}{6}+\frac{1}{6}=\frac{4}{6}$$

$$\frac{2}{3}-\frac{2}{3}\theta = \frac{1}{2}+\frac{1}{3}\left(\frac{1}{2}-2\theta\right) = \frac{1+x}{2}$$

$$\frac{1}{3}+\frac{2}{3}\theta = \frac{1}{2}-\frac{1}{3}\left(\frac{1}{2}-2\theta\right)$$

$$\frac{1+\varepsilon}{2}U = \begin{pmatrix} f_1 & g_1 \\ f_2 & g_2 \\ f_2 & g_2 \\ f_3 & g_3 \end{pmatrix} = \begin{pmatrix} \frac{2}{3}(f_1+g_2) & 0 \\ \frac{1}{3}(f_2+g_3) & \frac{1}{3}(f_1+g_2) \\ \frac{1}{3}(f_2+g_3) & \frac{1}{3}(f_1+g_2) \\ 0 & \frac{2}{3}(f_2+g_3) \end{pmatrix} + \begin{pmatrix} \frac{1}{3}(f_1-2g_2) & g_1 \\ -\frac{1}{3}(g_3-2f_2) & -\frac{1}{3}(f_1-g_2) \\ -\frac{1}{3}(g_3-2f_2) & -\frac{1}{3}(f_1-g_2) \\ f_3 & \frac{1}{3}(g_3-2f_2) \end{pmatrix}$$

$$U = \begin{pmatrix} u_{11} & u_{12} \\ u_{21} & u_{22} \\ u_{31} & u_{32} \\ u_{41} & u_{42} \end{pmatrix}$$

$$\mathcal{Z} = \frac{(1+\varepsilon)(1-\theta)}{3}\begin{pmatrix} f_1 & g_1 \\ f_2 & g_2 \\ f_2 & g_2 \\ f_3 & g_3 \end{pmatrix} + X\begin{pmatrix} f_1 & g_1 \\ f_2 & g_2 \\ f_2 & g_2 \\ f_2 & g_1 \end{pmatrix}$$

$$= \frac{\cancel{4}}{3}\frac{1+\varepsilon}{2}\frac{1-\theta}{2}\frac{1+\varepsilon}{2}U$$

$\cancel{f_2 = u}$

$$\frac{1-\varepsilon}{2}U + \frac{4}{3}\frac{1+\varepsilon}{2}\frac{1-\theta}{2}\frac{1+\varepsilon}{2}U$$

$$7 = \frac{3}{2}$$

$$\frac{1+\varepsilon}{2}U = \begin{pmatrix} u_{11} & u_{12} \\ \frac{u_{21}+u_{31}}{2} & \frac{u_{22}+u_{32}}{2} \\ \frac{u_{21}+u_{31}}{2} & \frac{u_{22}+u_{32}}{2} \\ u_{41} & u_{42} \end{pmatrix} = \begin{pmatrix} & u_{12} \\ & \\ & \\ u_{41} & \end{pmatrix} + \begin{pmatrix} \frac{2}{3}\left(u_{11} + \frac{u_{22}+u_{32}}{2}\right) \\ \\ \\ \end{pmatrix}$$

$$\frac{(1+\varepsilon)(1-\theta)(1+\varepsilon)}{6}U + XU$$

Let us now consider the 4×2 matrix S defined by

(A.39) $$S = P_+ Q_- P_+ U = \frac{1}{8}(1+\varepsilon)(1-\theta)(1+\varepsilon)\, U_{\frac{1+\varepsilon}{2}} \begin{pmatrix} \psi_1 & 0 \\ 0 & \psi_1 \\ \psi_2 & 0 \\ 0 & \psi_2 \end{pmatrix}$$

Since $\frac{1}{2}(1+\varepsilon)$ commutes with the operat

$$\begin{pmatrix} u_{11} & u_{12} \\ \frac{u_{21}+u_{31}}{2} & \frac{u_{22}+u_{32}}{2} \\ \frac{u_{21}+u_{31}}{2} & \frac{u_{22}+u_{32}}{2} \\ u_{41} & u_{42} \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \\ c & d \\ e & f \end{pmatrix}$$

$$\Gamma^{(\frac{3}{2})} = \begin{pmatrix} \frac{1}{3}(a-2d) & b \\ -\frac{1}{3}(f-2c) & -\frac{1}{3}(a-2d) \\ -\frac{1}{3}(f-2c) & -\frac{1}{3}(a-2d) \\ e & \frac{1}{3}(f-2c) \end{pmatrix}$$

$$= \begin{pmatrix} \frac{1}{3}(u_{11}-u_{22}-u_{32}) & u_{12} \\ -\frac{1}{3}(u_{42}-u_{21}-u_{31}) & -\frac{1}{3}(u_{11}-u_{22}-u_{32}) \\ -\frac{1}{3}(u_{42}-u_{21}-u_{31}) & -\frac{1}{3}(u_{11}+u_{22}-u_{32}) \\ u_{41} & \frac{1}{3}(u_{42}-u_{21}-u_{31}) \end{pmatrix}$$

FGA-SCI-04-006-08-DC-11

$6\,7.$

$$\frac{d}{d\tau}\left(\phi \frac{dx^\mu}{d\tau}\right) = \partial^\mu \phi.$$

$$\frac{d}{d\tau}\frac{x^\mu}{\tau} = -\frac{1}{\tau^2}x^\mu + \frac{1}{\tau}\frac{dx^\mu}{d\tau}$$

$$\tau \frac{d}{d\tau}\left(\frac{x^\mu}{\tau}\right) = \frac{dx^\mu}{d\tau} - \frac{x^\mu}{\tau}$$

$$-\tau \frac{d}{d\tau}\left(\frac{x^\mu}{\tau}\right) = \frac{x^\mu}{\tau} - \frac{dx^\mu}{d\tau}$$

$$\phi \frac{d^2 x^\mu}{d\tau^2} + \frac{d\phi}{d\tau}\frac{dx^\mu}{d\tau} = \partial^\mu\tau \frac{d\phi}{d\tau}$$

$$\frac{d^2 x^\mu}{d\tau^2} = -\frac{1}{\phi}\frac{d\phi}{d\tau}\frac{dx^\mu}{d\tau} + \partial^\mu\tau\,\frac{1}{\phi}\frac{d\phi}{d\tau}.$$

$$= \frac{1}{\phi}\frac{d\phi}{d\tau}\left(\partial^\mu\tau - \frac{dx^\mu}{d\tau}\right).$$

$$\tau = \sqrt{t^2 - x^2 - y^2 - z^2}$$

$$\partial_\mu \tau = \frac{x_\mu}{\tau}$$

$$\partial^\mu \tau = \frac{x^\mu}{\tau}$$

$$\frac{dx^\mu}{d\tau} = \frac{x^\mu}{\tau}\varphi(x^\mu).$$

$$\frac{d^2x^\mu}{d\tau^2} = \frac{x^\mu}{\tau}\partial_\mu\varphi \cdot \frac{dx^\mu}{d\tau} + \varphi\left(\frac{1}{\tau}\frac{dx^\mu}{d\tau} - \frac{1}{\tau^2}x^\mu\right).$$

$$\underline{\frac{d^2 x^\mu}{d\tau^2} = \frac{1}{\phi}\frac{d\phi}{d\tau}\left(\frac{x^\mu}{\tau} - \frac{dx^\mu}{d\tau}\right)} = \frac{d(\log\phi)}{d\tau}\left(\frac{x^\mu}{\tau} - \frac{dx^\mu}{d\tau}\right)$$

$$\frac{dx^\mu}{d\tau} = \varphi(x^\mu).$$

$$\frac{dx^\mu}{d\tau} = h(\tau)\,x^\mu.$$

$$\frac{d^2x^\mu}{d\tau^2} = h\frac{dx^\mu}{d\tau} + \frac{dh}{d\tau}x^\mu$$

$$=$$

$$\frac{d^2x^\mu}{d\tau^2} = \frac{\partial\varphi}{\partial x^\mu}\frac{dx^\mu}{d\tau} =$$

$$\phi = \frac{1}{1 - \frac{\tau^2}{R^2}} = \frac{1}{1-\frac{a}{R^2}}$$

$$\frac{d\phi}{da} = -\frac{1}{(1-\frac{a}{R^2})^2} \times -\frac{1}{R^2}$$

$$\frac{d\phi}{d\tau} = \frac{d\phi}{d(\tau^2)}2\tau = 2\tau\frac{d\phi}{da} = \frac{2\tau}{R^2}\frac{1}{\left(1-\frac{\tau^2}{R^2}\right)^2}$$

$$\left\{\begin{aligned} &\frac{dh}{d\tau} = \frac{1}{\phi\tau}\frac{d\phi}{d\tau} \\ &h = \frac{1}{\phi}\frac{d\phi}{d\tau} \end{aligned}\right.$$

$$\frac{d}{d(\frac{1}{\tau})}\phi$$

$$\frac{d^2x^\mu}{d\tau^2} = \frac{2}{R^2}x^\mu$$

$$\frac{1}{\tau\phi}\frac{d\phi}{d\tau} \times \tau^2\frac{d}{d\tau}.$$

$$\frac{1}{\phi}\frac{d\phi}{d\tau} = \frac{2\tau}{R^2}\frac{1}{\left(1-\frac{\tau^2}{R^2}\right)^2}$$

$$\frac{1}{\tau}\frac{1}{\phi}\frac{d\phi}{d\tau} = \frac{2}{R^2}\frac{1}{(1-\frac{\tau^2}{R^2})}$$

$$\langle e^{g\varphi(x)}, e^{g\varphi(y)} \rangle_0 = e^{g^2 i\Delta^{(+)}(x-y)}$$

$$F(g^2, x) = e^{g^2 i\Delta^{(+)}(x-y)}$$

$$F(0, x) = 1, \quad \frac{\partial F}{\partial g^2} = i\Delta^{(+)}(x)\, F(g^2, x).$$

$$F = 1 + \int d\varkappa^2 \; i\Delta^{(+)}(x, \varkappa^2)\, \rho(\varkappa^2)$$

$$\frac{\partial F}{\partial g^2} = \int d\varkappa^2 \; i\Delta^{(+)}(x, \varkappa^2)\, \frac{\partial \rho(\varkappa^2)}{\partial g^2}$$

$$= i\Delta^{(+)}(x, m^2) + \int d\varkappa^2 \; i\Delta^{(+)}(x, m^2)\, i\Delta^{(+)}(x, \varkappa^2)\, \rho(\varkappa^2)$$

$$= i\Delta^{(+)}(x, m^2) + \int_{(\varkappa+m)^2}^{\infty} dM^2 \int d\varkappa^2 \rho(\varkappa^2)\; i\Delta^{(+)}(x, M^2)\, \frac{1}{(4\pi)^2} \sqrt{\left[1-\left(\frac{m+\varkappa}{M}\right)^2\right]\left[1-\left(\frac{m-\varkappa}{M}\right)^2\right]}$$

$$= i\Delta^{(+)}(x, m^2) + \int_{(M+m)^2}^{\infty} d\varkappa^2 \int dM^2 \rho(M^2)\; i\Delta^{(+)}(x, \varkappa^2)\, \frac{1}{(4\pi)^2} \sqrt{\left[1-\left(\frac{m+M}{\varkappa}\right)^2\right]\left[1-\left(\frac{m-M}{\varkappa}\right)^2\right]}$$

$$\frac{\partial \rho(\varkappa^2)}{\partial g^2} = \delta(\varkappa^2 - m^2) + \int^{(\varkappa-m)^2} dM^2 \rho(M^2)\, \frac{1}{(4\pi)^2} \sqrt{\left[1-\left(\frac{m+M}{\varkappa}\right)^2\right]\left[1-\left(\frac{m-M}{\varkappa}\right)^2\right]}$$

This is the integral eq. for the determination of ρ.

Put $m=0$

$$\frac{\partial \rho(\varkappa^2)}{\partial g^2} = \delta(\varkappa^2) + \int_0^{\varkappa^2} dM^2 \rho(M^2)\, \frac{1}{(4\pi)^2} \left[1 - \frac{M^2}{\varkappa^2}\right]$$