

Wave operator and propagator

SO(3) irreps	Fundamental fields	Multiplicities
$\sigma_0^{\#1} == 0$	$\epsilon \eta_{\alpha\beta\chi\delta} \partial^\delta \sigma^{\alpha\beta\chi} == 0$	1
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{0+}^{\#1} - 2 i k \sigma_{0+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha + 2 \partial_\chi \partial^\chi \partial_\beta \sigma^{\alpha\beta}_\alpha$	1
$\tau_1^{\#2\alpha} + 2 i k \sigma_1^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta} + 2 \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau_1^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3
$\tau_{1+}^{\#1\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha}$	3
$\sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\tau_{2+}^{\#1\alpha\beta} == 0$	$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi +$ $3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} == 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} +$ $3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} +$ $3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi_\chi$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$	$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} +$ $2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}_\chi == 2 \partial_\delta \partial^\beta \partial^\alpha \sigma^{\chi\delta}_\chi +$ $3 (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:		25

$\sigma_{1^+}^{\#1} \dagger \alpha\beta$	$\frac{1}{k^2(2r_1+r_5)}$	$\sigma_{1^+}^{\#2}$	$\tau_{1^+}^{\#1} \alpha\beta$	$\sigma_{1^+}^{\#1} \alpha$	$\sigma_{1^+}^{\#2} \alpha$	$\tau_{1^+}^{\#1} \alpha$	$\tau_{1^+}^{\#2} \alpha$
$\sigma_{1^+}^{\#1} \dagger \alpha\beta$	0	0	0	0	0	0	0
$\sigma_{1^+}^{\#2} \dagger \alpha\beta$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#1} \dagger \alpha\beta$	0	0	0	0	0	0	0
$\sigma_{1^+}^{\#1} \dagger \alpha$	0	0	0	$\frac{1}{k^2(r_1+r_5)}$	$\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$	0	$\frac{2i}{k(1+2k^2)(r_1+r_5)}$
$\sigma_{1^+}^{\#2} \dagger \alpha$	0	0	0	$\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$	$\frac{3k^2(r_1+r_5)+2t_3}{(k+2k^2)^2(r_1+r_5)t_3}$	0	$\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$
$\tau_{1^+}^{\#1} \dagger \alpha$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#2} \dagger \alpha$	0	0	0	$-\frac{2i}{k(1+2k^2)(r_1+r_5)}$	$-\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$	0	$\frac{6k^2(r_1+r_5)+4t_3}{(1+2k^2)^2(r_1+r_5)t_3}$

Quadratic (free) action

$$S = \int \int \int \left(\frac{1}{3} (-2 t_3 \omega^\alpha_{\omega, \kappa} \omega^\alpha_{\omega, \kappa} + 3 f^{\alpha\beta} \tau_{\alpha\beta} + 3 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 4 t_3 \omega^\kappa_\alpha \partial_\kappa \omega^\alpha_{\omega, \kappa} \partial_\kappa \omega^\alpha_{\omega, \kappa} - 4 t_3 \omega^\kappa_\alpha \partial_\kappa \omega^\alpha_{\omega, \kappa} \partial_\kappa f^\alpha_{\omega, \kappa} + 2 t_3 \partial_\kappa f^\alpha_{\omega, \kappa} \partial_\kappa f^\alpha_{\omega, \kappa} - 4 r_1 \partial_\beta \omega_{\alpha\theta} \partial^\theta \omega^{\alpha\beta}_\omega + 2 r_1 \partial_\beta \omega_{\alpha\theta} \partial^\theta \omega^{\alpha\beta}_\omega - 8 r_1 \partial_\beta \omega_{\theta\alpha} \partial^\theta \omega^{\alpha\beta}_\omega - 2 r_1 \partial_\theta \omega_{\alpha\beta} \partial^\theta \omega^{\alpha\beta}_\omega + 2 r_1 \partial_\theta \omega_{\alpha\beta} \partial^\theta \omega^{\alpha\beta}_\omega + 2 r_5 \partial_\theta \omega^\kappa_\alpha \partial^\theta \omega^\alpha_{\omega, \kappa} - 3 r_5 \partial_\theta \omega^\kappa_\alpha \partial^\theta \omega^\alpha_{\omega, \kappa} + 2 t_3 \partial_\kappa f^\alpha_{\omega, \kappa} \partial_\kappa f^\alpha_{\omega, \kappa} - 4 t_3 \partial_\kappa f^\alpha_{\omega, \kappa} \partial_\kappa f^\alpha_{\omega, \kappa} - 3 r_5 \partial_\alpha \omega^\kappa_{\omega, \kappa} \partial_\kappa \omega^\alpha_{\omega, \kappa} + 3 r_5 \partial_\alpha \omega^\kappa_{\omega, \kappa} \partial_\kappa \omega^\alpha_{\omega, \kappa} - 6 r_5 \partial^\theta \omega^\alpha_{\omega, \kappa} \partial_\kappa \omega^\alpha_{\omega, \kappa} + 3 r_5 \partial_\alpha \omega^\alpha_{\omega, \kappa} \partial_\kappa \omega^\kappa_{\omega, \kappa} - 6 r_5 \partial^\theta \omega^\alpha_{\omega, \kappa} \partial_\kappa \omega^\alpha_{\omega, \kappa}) [t, x, y, z] dz dy dx dt$$

	$\omega_{1+}^{\#1+\alpha\beta}$	$\omega_{1+}^{\#2+\alpha\beta}$	$f_{1+}^{\#1+\alpha\beta}$	$\omega_{1-}^{\#1-\alpha}$	$\omega_{1-}^{\#2-\alpha}$	$f_{1-}^{\#1-\alpha}$	$f_{1-}^{\#2-\alpha}$
$\omega_{1+}^{\#1+\alpha\beta}$	$k^2(2r_1+r_5)$	0	0	0	0	0	0
$\omega_{1+}^{\#2+\alpha\beta}$	0	0	0	0	0	0	0
$f_{1+}^{\#1+\alpha\beta}$	0	0	0	0	0	0	0
$\omega_{1-}^{\#1+\alpha}$	0	0	0	$k^2(r_1+r_5)+\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3}ikt_3$
$\omega_{1-}^{\#2+\alpha}$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_3$
$f_{1-}^{\#1+\alpha}$	0	0	0	0	0	0	0
$f_{1-}^{\#2+\alpha}$	0	0	0	$\frac{2ikt_3}{3}$	$-\frac{1}{3}i\sqrt{2}kt_3$	0	$\frac{2k^2t_3}{3}$

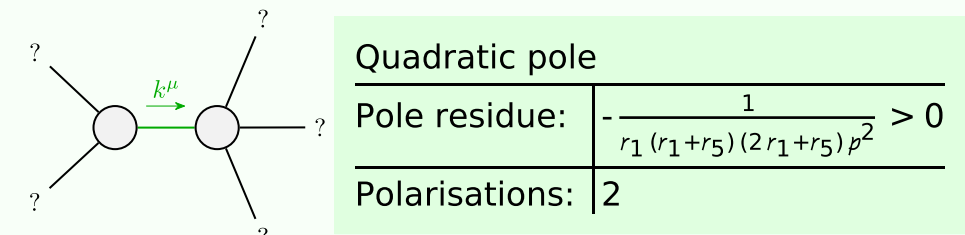
$$\begin{array}{c}
\begin{array}{c} \omega_{2+}^{\#1} \dagger^{\alpha\beta} \\ f_{2+}^{\#1} \dagger^{\alpha\beta} \\ \omega_{2-}^{\#1} \dagger^{\alpha\beta\chi} \end{array}
\begin{array}{|c|c|c|}
\hline
0 & 0 & 0 \\
\hline
0 & 0 & 0 \\
\hline
0 & 0 & k^2 r_1 \\
\hline
\end{array}
\end{array}
\begin{array}{c}
\omega_{2+}^{\#1} \dagger^{\alpha\beta} \quad f_{2+}^{\#1} \dagger^{\alpha\beta} \quad \omega_{2-}^{\#1} \dagger^{\alpha\beta\chi} \\
\begin{array}{|c|c|c|}
\hline
0 & 0 & 0 \\
\hline
0 & 0 & 0 \\
\hline
0 & 0 & \frac{1}{k^2 r_1} \\
\hline
\end{array}
\end{array}$$

$$\begin{array}{c}
\begin{array}{c} \sigma_{0+}^{\#1} \dagger \\ \tau_{0+}^{\#1} \dagger \\ \tau_{0+}^{\#2} \dagger \\ \sigma_{0+}^{\#1} \dagger \end{array}
\begin{array}{|c|c|c|c|}
\hline
\frac{1}{(1+2k^2)^2 t_3} & -\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3} & 0 & 0 \\
\hline
\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3} & \frac{2k^2}{(1+2k^2)^2 t_3} & 0 & 0 \\
\hline
0 & 0 & 0 & 0 \\
\hline
0 & 0 & 0 & 0 \\
\hline
\end{array}
\end{array}
\begin{array}{c}
\sigma_{0+}^{\#1} \dagger \quad \tau_{0+}^{\#1} \dagger \quad \tau_{0+}^{\#2} \dagger \quad \sigma_{0+}^{\#1} \dagger \\
\begin{array}{|c|c|c|c|}
\hline
\frac{1}{(1+2k^2)^2 t_3} & -\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3} & 0 & 0 \\
\hline
\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3} & \frac{2k^2}{(1+2k^2)^2 t_3} & 0 & 0 \\
\hline
0 & 0 & 0 & 0 \\
\hline
0 & 0 & 0 & 0 \\
\hline
\end{array}
\end{array}$$

$$\begin{array}{c}
\begin{array}{c} \sigma_{2+}^{\#1} \dagger^{\alpha\beta} \\ \tau_{2+}^{\#1} \dagger^{\alpha\beta} \\ \sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi} \end{array}
\begin{array}{|c|c|c|}
\hline
0 & 0 & 0 \\
\hline
0 & 0 & 0 \\
\hline
0 & 0 & \frac{1}{k^2 r_1} \\
\hline
\end{array}
\end{array}
\begin{array}{c}
\sigma_{2+}^{\#1} \dagger^{\alpha\beta} \quad \tau_{2+}^{\#1} \dagger^{\alpha\beta} \quad \sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi} \\
\begin{array}{|c|c|c|}
\hline
0 & 0 & 0 \\
\hline
0 & 0 & 0 \\
\hline
0 & 0 & \frac{1}{k^2 r_1} \\
\hline
\end{array}
\end{array}$$

$$\begin{array}{c}
\begin{array}{c} f_{0+}^{\#1} \dagger \\ \omega_{0+}^{\#1} \dagger \end{array}
\begin{array}{|c|c|c|c|}
\hline
0 & 0 & 0 & 0 \\
\hline
0 & 0 & 0 & 0 \\
\hline
-i\sqrt{2}kt_3 & 2k^2 t_3 & 0 & 0 \\
\hline
t_3 & i\sqrt{2}kt_3 & 0 & 0 \\
\hline
\end{array}
\end{array}
\begin{array}{c}
f_{0+}^{\#1} \dagger \quad \omega_{0+}^{\#1} \dagger \\
\begin{array}{|c|c|c|c|}
\hline
0 & 0 & 0 & 0 \\
\hline
0 & 0 & 0 & 0 \\
\hline
-i\sqrt{2}kt_3 & 2k^2 t_3 & 0 & 0 \\
\hline
t_3 & i\sqrt{2}kt_3 & 0 & 0 \\
\hline
\end{array}
\end{array}$$

Massive and massless spectra



(No massive particles)

Unitarity conditions

$$r_1 < 0 \&\& (r_5 < -r_1 \parallel r_5 > -2r_1) \parallel r_1 > 0 \&\& -2r_1 < r_5 < -r_1$$