

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
0	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{i\sqrt{2}k}{t_1+k^2}t_1$	0	0	0	0
$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{2k^2r_1+t_1}{(1+k^2)^2}t_1^2$	$-\frac{i(2k^3r_1-kt_1)}{(1+k^2)^2}t_1^2$	0	0	0	0
$\frac{i\sqrt{2}k}{t_1+k^2}t_1$	$\frac{i(2k^3r_1-kt_1)}{(1+k^2)^2}t_1^2$	$\frac{-2k^4r_1+k^2t_1}{(1+k^2)^2}t_1^2$	0	0	0	0
0	0	0	$\frac{2(t_1+t_3)}{3t_1t_3}$	$-\frac{\sqrt{2}(t_1-2t_3)}{3(1+2k^2)}t_1t_3$	0	$-\frac{2ikt_1-4ikt_3}{3t_1t_3+6k^2t_1t_3}$
0	0	0	0	$\frac{t_1+4t_3}{3(1+2k^2)^2}t_1t_3$	0	$\frac{i\sqrt{2}k(t_1+4t_3)}{3(1+2k^2)^2}t_1t_3$
0	0	0	0	0	0	0
0	0	0	$\frac{2ik(t_1-2t_3)}{3t_1t_3+6k^2t_1t_3}$	$-\frac{i\sqrt{2}k(t_1+4t_3)}{3(1+2k^2)^2}t_1t_3$	0	$\frac{2k^2(t_1+4t_3)}{3(1+2k^2)^2}t_1t_3$

Quadratic (free) action

$$S = \iiint (\frac{1}{6} (2 \omega_{\alpha}^{\alpha i} (t_1 \omega_{\theta}^{\theta} - 2 t_3 \omega_{\kappa}^{\kappa}) + 6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 4 t_1 \omega_{\alpha}^{\theta} \partial_{\theta} f^{\alpha i} + 8 t_3 \omega_{\alpha}^{\kappa} \partial_{\kappa} f^{\alpha i} + 4 t_1 \omega_{\theta}^{\theta} \partial_{\theta} f^{\alpha} - 8 t_3 \omega_{\kappa}^{\kappa} \partial_{\kappa} f^{\alpha} - 2 t_1 \partial_{\theta} f^{\theta} \partial_{\theta} f^{\alpha} + 4 t_3 \partial_{\kappa} f^{\kappa} \partial_{\theta} f^{\alpha} - 6 r_1 \partial_{\beta} \omega_{\theta}^{\theta} \partial_{\theta} \omega_{\alpha}^{\alpha\beta} + 6 r_1 \partial_{\theta} \omega_{\beta}^{\theta} \partial_{\theta} \omega_{\alpha}^{\alpha\beta} - 2 t_1 \partial_{\theta} f^{\alpha i} \partial_{\theta} f_{\alpha}^{\theta} + 4 t_1 \partial_{\theta} f^{\alpha} \partial_{\theta} f_{\alpha}^{\theta} + 6 r_1 \partial_{\alpha} \omega^{\alpha\beta i} \partial_{\theta} \omega_{\theta}^{\theta} + 12 r_1 \partial_{\theta} \omega_{\beta}^{\theta} \partial_{\theta} \omega_{\alpha}^{\alpha\beta} - 6 t_1 \partial_{\theta} \omega_{\beta}^{\theta} \partial_{\theta} f^{\alpha i} - 3 t_1 \partial_{\alpha} f_{\theta i} \partial_{\theta} f^{\alpha i} + 3 t_1 \partial_{\theta} f_{\alpha i} \partial_{\theta} f^{\alpha i} + 3 t_1 \partial_{\theta} f_{\alpha} \partial_{\theta} f^{\alpha i} + 6 t_1 \omega_{\alpha\theta i} (\omega^{\alpha i\theta} + 2 \partial^{\theta} f^{\alpha i}) - 8 r_1 \partial_{\beta} \omega_{\alpha i\theta} \partial^{\theta} \omega_{\alpha}^{\alpha\beta i} + 4 r_1 \partial_{\beta} \omega_{\alpha\theta i} \partial^{\theta} \omega_{\alpha}^{\alpha\beta i} - 16 r_1 \partial_{\beta} \omega_{\theta\alpha} \partial^{\theta} \omega_{\alpha\beta i} - 4 r_1 \partial_{\theta} \omega_{\alpha\beta\theta} \partial^{\theta} \omega_{\alpha}^{\alpha\beta i} + 4 r_1 \partial_{\theta} \omega_{\alpha\beta i} \partial^{\theta} \omega_{\alpha}^{\alpha\beta i} + 4 r_1 \partial_{\theta} \omega_{\alpha i\beta} \partial^{\theta} \omega_{\alpha\beta}^{\alpha i} + 4 t_3 \partial_{\theta} f^{\alpha i} \partial_{\kappa} f_{\alpha}^{\kappa} - 8 t_3 \partial_{\theta} f^{\alpha} \partial_{\kappa} f_{\alpha}^{\kappa}) [t, x, y, z] dz dy dx dt$$

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$k^2 r_1 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
0	0	0	$\frac{1}{6}(t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$\frac{1}{3}ik(t_1-2t_3)$
0	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}k(t_1+t_3)$
0	0	0	0	0	0	0
0	0	0	$-\frac{1}{3}ik(t_1-2t_3)$	$-\frac{1}{3}i\sqrt{2}k(t_1+t_3)$	0	$\frac{2}{3}k^2(t_1+t_3)$

Source constraints/gauge generators

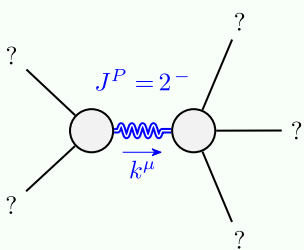
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} - 2ik\sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2ik\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta} - 2ik\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	16

$$\begin{matrix} & \omega_{2+}^{\#1} \dagger^{\alpha\beta} & f_{2+}^{\#1} \dagger^{\alpha\beta} & \omega_{2-}^{\#1} \dagger^{\alpha\beta\chi} \\ \omega_{2+}^{\#1} \dagger^{\alpha\beta} & \begin{bmatrix} \frac{t_1}{2} & -\frac{ikt_1}{\sqrt{2}} & 0 \end{bmatrix} \\ f_{2+}^{\#1} \dagger^{\alpha\beta} & \begin{bmatrix} \frac{ikt_1}{\sqrt{2}} & k^2 t_1 & 0 \end{bmatrix} \\ \omega_{2-}^{\#1} \dagger^{\alpha\beta\chi} & \begin{bmatrix} 0 & 0 & k^2 r_1 + \frac{t_1}{2} \end{bmatrix} \end{matrix}$$
$$\begin{matrix} & \omega_{0+}^{\#1} \dagger & f_{0+}^{\#1} \dagger & f_{0+}^{\#2} \dagger & \omega_{0-}^{\#1} \dagger \\ \omega_{0+}^{\#1} \dagger & \begin{bmatrix} t_3 & -i\sqrt{2}kt_3 & 0 & 0 \end{bmatrix} \\ f_{0+}^{\#1} \dagger & \begin{bmatrix} i\sqrt{2}kt_3 & 2k^2t_3 & 0 & 0 \end{bmatrix} \\ f_{0+}^{\#2} \dagger & \begin{bmatrix} 0 & 0 & 0 & 0 \end{bmatrix} \\ \omega_{0-}^{\#1} \dagger & \begin{bmatrix} 0 & 0 & 0 & -t_1 \end{bmatrix} \end{matrix}$$

$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#2} \dagger$	$\sigma_{0-}^{\#1} \dagger$
$\frac{1}{(1+2k^2)^2}t_3$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2}t_3$	0	0
$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_3$	$\frac{2k^2}{(1+2k^2)^2}t_3$	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$
$\frac{2}{(1+2k^2)^2}t_1$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	0
$\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	$\frac{4k^2}{(1+2k^2)^2}t_1$	0
0	0	$\frac{2}{2k^2r_1+t_1}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_1 < 0 \&\& t_1 > 0$