

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S_F = \iiint [(\frac{1}{6} (-2 t_1 \omega_{\kappa}^{\alpha \lambda} \omega_{\kappa \alpha}^{\kappa} - 6 t_1 \omega_{\kappa \lambda}^{\kappa \lambda} \omega_{\kappa \lambda}^{\prime} + 6 f^{\alpha \beta} \tau_{\alpha \beta} + 6 \omega^{\alpha \beta \chi} \sigma_{\alpha \beta \chi} + 6 r_1 \partial_{\lambda} \omega_{\kappa}^{\kappa \lambda} \partial_{\lambda} \omega_{\alpha}^{\alpha} - 4 r_1 \partial^{\beta} \omega_{\kappa}^{\theta \alpha} \partial_{\theta} \omega_{\alpha \beta}^{\kappa} - 4 r_1 \partial_{\theta} \omega_{\alpha \beta}^{\kappa} \partial_{\kappa} \omega^{\alpha \beta \theta} + 4 r_1 \partial_{\theta} \omega_{\alpha \beta}^{\kappa} \partial_{\kappa} \omega^{\theta \alpha \beta} - 18 r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta \kappa \lambda} + 24 r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta \kappa \lambda} + 18 r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta \kappa \lambda} - 24 r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta \kappa \lambda} + 6 r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega^{\kappa \lambda \theta} - 12 r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa \lambda \theta} - 3 t_1 \partial^{\alpha} f_{\theta \kappa} \partial^{\kappa} f_{\alpha}^{\theta} - 3 t_1 \partial^{\alpha} f_{\kappa \theta} \partial^{\kappa} f_{\alpha}^{\theta} - 3 t_1 \partial^{\alpha} f_{\lambda}^{\theta} \partial^{\kappa} f_{\kappa}^{\lambda} \partial^{\alpha} f_{\alpha \lambda} + 2 t_1 \omega_{\kappa \alpha}^{\alpha} \partial^{\kappa} f_{\lambda}^{\prime} + 2 t_1 \omega_{\kappa \lambda}^{\lambda} \partial^{\kappa} f_{\prime}^{\prime} + 4 t_1 \partial^{\alpha} f_{\kappa \alpha} \partial^{\kappa} f_{\prime}^{\prime} - 2 t_1 \partial_{\kappa} f_{\lambda}^{\lambda} \partial^{\kappa} f_{\prime}^{\prime} + 12 t_1 \omega_{\kappa \theta} \partial^{\kappa} f_{\theta}^{\lambda} - 2 t_1 \omega_{\lambda \alpha}^{\alpha} \partial^{\kappa} f_{\kappa}^{\prime} - 2 t_1 \omega_{\lambda \lambda}^{\lambda} \partial^{\kappa} f_{\prime}^{\prime} + 3 t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} + 3 t_1 \partial_{\kappa} f_{\lambda}^{\theta} \partial^{\kappa} f_{\lambda}^{\theta} - 2 t_1 \partial^{\alpha} f_{\lambda}^{\theta} \partial^{\kappa} f_{\lambda \kappa}^{\alpha} \partial^{\kappa} f_{\alpha}^{\theta} + 4 r_1 \partial_{\kappa} \omega^{\alpha \beta \theta} \partial^{\kappa} \omega_{\alpha \beta}^{\lambda} - 4 r_1 \partial_{\kappa} \omega^{\theta \alpha \beta} \partial^{\kappa} \omega_{\alpha \beta \theta} + 4 r_1 \partial^{\beta} \omega_{\lambda}^{\alpha \lambda} \partial_{\alpha} \omega_{\alpha \beta}^{\prime} + 8 r_1 \partial^{\beta} \omega_{\lambda}^{\lambda \alpha} \partial_{\alpha} \omega_{\alpha \beta}^{\prime} - 24 r_3 \partial^{\beta} \omega_{\lambda}^{\lambda \alpha} \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta \kappa} - 24 r_3 \partial_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta \kappa} - 18 r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\alpha}^{\theta \kappa} + 24 r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\alpha}^{\theta \kappa})][t, x, y, z] d^3 z d^4 x d^4 t$$

$\sigma_{1+}^{\#1} \dagger^{\alpha \beta}$	$\sigma_{1+}^{\#2} \dagger^{\alpha \beta}$	$\tau_{1+}^{\#1} \dagger^{\alpha \beta}$	$\sigma_{1-}^{\#1} \dagger^{\alpha}$	$\sigma_{1-}^{\#2} \dagger^{\alpha}$	$\tau_{1-}^{\#1} \dagger^{\alpha}$	$\tau_{1-}^{\#2} \dagger^{\alpha}$
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
$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{2 k^2 r_1+t_1}{(1+k^2)^2 t_1^2}$	$-\frac{i(2 k^3 r_1+k t_1)}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\frac{i \sqrt{2} k}{t_1+k^2 t_1}$	$\frac{i(2 k^3 r_1+k t_1)}{(1+k^2)^2 t_1^2}$	$\frac{-2 k^4 r_1+k^2 t_1}{(1+k^2)^2 t_1^2}$	0	0	0	0
0	0	0	$\frac{6}{(3+4 k^2)^2 t_1}$	$\frac{6 \sqrt{2}}{(3+4 k^2)^2 t_1}$	0	$\frac{12 i k}{(3+4 k^2)^2 t_1}$
0	0	0	0	$\frac{12}{(3+4 k^2)^2 t_1}$	0	$\frac{12 i \sqrt{2} k}{(3+4 k^2)^2 t_1}$
0	0	0	0	0	0	0
0	0	0	$-\frac{12 i k}{(3+4 k^2)^2 t_1}$	$-\frac{12 i \sqrt{2} k}{(3+4 k^2)^2 t_1}$	0	$\frac{24 k^2}{(3+4 k^2)^2 t_1}$

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

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

Source constraints/gauge generators

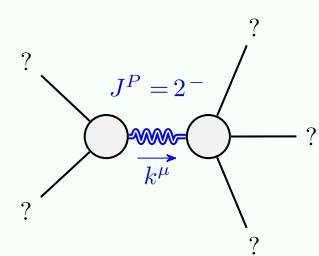
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2 \alpha} + 2 i k \sigma_{1-}^{\#1 \alpha} == 0$	3
$\tau_{1-}^{\#1 \alpha} == 0$	3
$\sigma_{1-}^{\#1 \alpha} == \sigma_{1-}^{\#2 \alpha}$	3
$\tau_{1+}^{\#1 \alpha \beta} + i k \sigma_{1+}^{\#2 \alpha \beta} == 0$	3
$\tau_{2+}^{\#1 \alpha \beta} - 2 i k \sigma_{2+}^{\#1 \alpha \beta} == 0$	5
Total constraints:	19

$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1} \dagger$	$f_{0+}^{\#2} \dagger$	$\omega_{0-}^{\#1} \dagger$
$6 k^2 (-r_1+r_3)$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-t_1$

$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#2} \dagger$	$\sigma_{0-}^{\#1} \dagger$
$\frac{1}{6 k^2 (-r_1+r_3)}$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

$\omega_{2+}^{\#1} \dagger^{\alpha \beta}$	$f_{2+}^{\#1} \dagger^{\alpha \beta}$	$\omega_{2-}^{\#1} \dagger^{\alpha \beta \chi}$
$\frac{t_1}{2}$	$-\frac{i k t_1}{\sqrt{2}}$	0
$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0
0	0	$k^2 r_1+\frac{t_1}{2}$

Massive and massless spectra



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

(No massless particles)

Unitarity conditions

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