

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$S_F =$

$$\begin{aligned} & \iiint \left(\frac{1}{6} (4t_2 \omega_{\lambda'}^{\kappa\lambda} \omega_{\kappa\lambda'}' + 2t_2 \omega_{\kappa\lambda'}^{\kappa\lambda} \omega_{\lambda'}^{\kappa\lambda} + 6f^{\alpha\beta} \tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 3r_3 \partial_{\lambda} \omega_{\kappa}^{\kappa\lambda} \right. \\ & \partial' \omega_{\lambda}^{\alpha} - 6r_5 \partial_{\lambda} \omega_{\kappa}^{\kappa\lambda} \partial' \omega_{\lambda}^{\alpha} + 3r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega_{\lambda}^{\theta\kappa\lambda} - 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega_{\lambda}^{\theta\kappa\lambda} - \\ & 3r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\alpha} \omega_{\lambda}^{\theta\kappa\lambda} + 6r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\alpha} \omega_{\lambda}^{\theta\kappa\lambda} - 3r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega_{\lambda}^{\kappa\lambda\theta} - 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega_{\lambda}^{\kappa\lambda\theta} \\ & \partial_{\kappa} \omega_{\lambda}^{\kappa\lambda\theta} + 6r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\alpha} \omega_{\lambda}^{\kappa\lambda\theta} + 12r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\alpha} \omega_{\lambda}^{\kappa\lambda\theta} + t_2 \partial^{\alpha} f_{\theta\kappa} \partial^{\kappa} f_{\alpha}^{\theta} + 2t_2 \omega_{\theta\kappa} \partial^{\kappa} f^{\iota\theta} - 4t_2 \omega_{\iota\kappa\theta} \partial^{\kappa} f^{\iota\theta} - \\ & 2t_2 \omega_{\theta\iota\kappa} \partial^{\kappa} f^{\iota\theta} + 4t_2 \omega_{\theta\kappa\iota} \partial^{\kappa} f^{\iota\theta} - t_2 \partial^{\alpha} f_{\lambda}^{\alpha} \partial_{\kappa} f_{\lambda\alpha}^{\kappa} - t_2 \partial_{\kappa} f_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} + 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} + \\ & t_2 \partial_{\kappa} f_{\lambda}^{\alpha} \partial^{\kappa} f_{\lambda}^{\theta} - 24r_3 \partial^{\beta} \omega_{\lambda}^{\lambda\alpha} \partial_{\lambda} \omega_{\alpha\beta}^{\lambda} - 3r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} + 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} + \\ & \left. 3r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} - 6r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} \right) [t, x, y, z] dz dy dx dt \end{aligned}$$

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$-\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	0	0	0	0
$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(k+k^3)^2(2r_3+r_5)t_2}$	$\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0	0
$-\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	$-\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0	0
0	0	0	$\frac{2}{k^2(r_3+2r_5)}$	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$k^2(2r_3+r_5) + \frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2t_2}{3}$	0	0	0	0
0	0	0	$\frac{1}{2}k^2(r_3+2r_5)$	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Source constraints/gauge generators

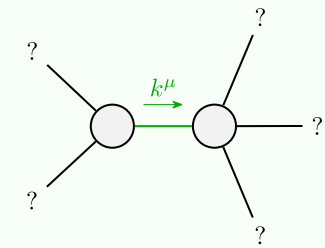
SO(3) irreps	Multiplicities
$\sigma_{0+}^{\#1} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{0+}^{\#2} == 0$	1
$\tau_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	25

$\sigma_{0+}^{\#1} \dagger$	0	0	0	0
$\tau_{0+}^{\#1} \dagger$	0	0	0	0
$\tau_{0+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0-}^{\#1} \dagger$	0	0	0	$\frac{1}{t_2}$

$\omega_{0+}^{\#1} \dagger$	0	0	0	0
$f_{0+}^{\#1} \dagger$	0	0	0	0
$f_{0+}^{\#2} \dagger$	0	0	0	0
$\omega_{0-}^{\#1} \dagger$	0	0	0	t_2

$\omega_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{3k^2r_3}{2}$	0	0	$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{2}{3k^2r_3}$	0	0
$f_{2+}^{\#1} \dagger^{\alpha\beta}$	0	0	0	$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$\omega_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	0	$\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	0

Massive and massless spectra



Quadratic pole

Pole residue:	$-\frac{1}{r_3(2r_3+r_5)(r_3+2r_5)p^2} > 0$
Polarisations:	2

(No massive particles)

Unitarity conditions

$$r_3 < 0 \&\& (r_5 < -\frac{r_3}{2} \parallel r_5 > -2r_3) \parallel r_3 > 0 \&\& -2r_3 < r_5 < -\frac{r_3}{2}$$