

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$\begin{aligned} S_F = & \iiint \left(\frac{1}{6} (4t_2 \omega_{\kappa\lambda}^{\kappa\lambda} \omega_{\kappa\lambda}^{\prime} + 2t_2 \omega_{\kappa\lambda}^{\prime} \omega_{\kappa\lambda}^{\kappa\lambda} + \right. \\ & 6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 4r_2 \partial^\beta \omega_{\alpha\beta}^{\kappa} \partial_\theta \omega_{\alpha\beta}^{\kappa} - 2r_2 \partial_\theta \omega_{\alpha\beta}^{\kappa} \partial_\kappa \omega^{\alpha\beta\theta} - \\ & 4r_2 \partial_\theta \omega_{\alpha\beta}^{\kappa} \partial_\kappa \omega^{\theta\alpha\beta} + 6r_3 \partial_\alpha \omega_{\lambda}^{\alpha} \partial_\theta \omega^{\theta\kappa\lambda} - 6r_3 \partial_\theta \omega_{\lambda}^{\alpha} \partial_\alpha \omega^{\theta\kappa\lambda} + \\ & t_2 \partial^\alpha f_{\theta\kappa} \partial_\kappa f_{\alpha}^{\theta} - t_2 \partial^\alpha f_{\kappa\theta} \partial_\theta f_{\alpha}^{\theta} + t_2 \partial^\alpha f_{\lambda}^{\theta} \partial_\kappa f_{\alpha\lambda}^{\theta} + 2t_2 \omega_{\theta\kappa} \partial_\kappa f_{\lambda}^{\theta} - \\ & 4t_2 \omega_{\lambda\theta} \partial_\kappa f^{\theta\theta} - 2t_2 \omega_{\theta\kappa} \partial_\kappa f^{\theta\theta} + 4t_2 \omega_{\theta\kappa} \partial_\kappa f^{\theta\theta} - t_2 \partial^\alpha f_{\lambda}^{\theta} \partial_\kappa f_{\alpha\lambda}^{\theta} - \\ & t_2 \partial_\kappa f_{\theta}^{\lambda} \partial^\lambda \omega_{\alpha\beta}^{\theta} + t_2 \partial_\kappa f_{\lambda}^{\theta} \partial_\theta \omega_{\alpha\beta}^{\theta} + 2r_2 \partial_\kappa \omega_{\alpha\beta}^{\theta} \partial^\kappa \omega_{\alpha\beta\theta} + 4r_2 \partial_\kappa \omega^{\theta\alpha\beta} \partial^\kappa \omega_{\alpha\beta\theta} - \\ & 4r_2 \partial^\beta \omega_{\lambda}^{\alpha\lambda} \partial_\lambda \omega_{\alpha\beta}^{\prime} + 4r_2 \partial^\beta \omega_{\lambda}^{\lambda\alpha} \partial_\lambda \omega_{\alpha\beta}^{\prime} - 24r_3 \partial^\beta \omega_{\lambda}^{\lambda\alpha} \partial_\lambda \omega_{\alpha\beta}^{\prime} - \\ & \left. 6r_3 \partial_\alpha \omega_{\lambda}^{\alpha} \partial^\lambda \omega_{\theta}^{\theta\kappa} + 6r_3 \partial_\theta \omega_{\lambda}^{\alpha} \partial^\lambda \omega_{\alpha}^{\theta\kappa} \right) [t, x, y, z] dz dy dx dt \end{aligned}$$

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1-}^{\#1} \dagger^{\alpha}$	$\sigma_{1-}^{\#2} \dagger^{\alpha}$	$\tau_{1-}^{\#1} \dagger^{\alpha}$	$\tau_{1-}^{\#2} \dagger^{\alpha}$
$\frac{2}{3k^2 r_3}$	$-\frac{2\sqrt{2}}{3k^2 r_3 + 3k^4 r_3}$	$-\frac{2i\sqrt{2}}{3kr_3 + 3k^3 r_3}$	0	0	0	0
$-\frac{2\sqrt{2}}{3k^2 r_3 + 3k^4 r_3}$	$\frac{9k^2 r_3 + 4t_2}{3(k+k^2)^2 r_3 t_2}$	$\frac{i(9k^2 r_3 + 4t_2)}{3k(1+k^2)^2 r_3 t_2}$	0	0	0	0
$\frac{2i\sqrt{2}}{3kr_3 + 3k^3 r_3}$	$-\frac{i(9k^2 r_3 + 4t_2)}{3k(1+k^2)^2 r_3 t_2}$	$\frac{9k^2 r_3 + 4t_2}{3(1+k^2)^2 r_3 t_2}$	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1-}^{\#1} \dagger^{\alpha}$	$\omega_{1-}^{\#2} \dagger^{\alpha}$	$f_{1-}^{\#1} \dagger^{\alpha}$	$f_{1-}^{\#2} \dagger^{\alpha}$
$\frac{1}{6} (9k^2 r_3 + 4t_2)$	$\frac{\sqrt{2} t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	0	0	0	0
$\frac{\sqrt{2} t_2}{3}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$-\frac{1}{3} i \sqrt{2} k t_2$	$-\frac{1}{3} i k t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

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

	$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1} \dagger$	$f_{0+}^{\#2} \dagger$	$\omega_{0-}^{\#1} \dagger$
$\omega_{0+}^{\#1} \dagger$	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	$k^2 r_2 + t_2$

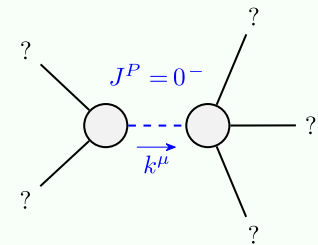
Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\sigma_{1-}^{\#2\alpha} == 0$	3
$\sigma_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	28

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

	$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#2} \dagger$	$\sigma_{0-}^{\#1} \dagger$
$\sigma_{0+}^{\#1} \dagger$	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	$\frac{1}{k^2 r_2 + t_2}$

Massive and massless spectra



Massive particle

Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$$r_2 < 0 \ \&\& \ t_2 > 0$$