

Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{0+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1
$\sigma_{0+}^{\#1} == 0$	xAct`xTensor`Private`Reconstruct[Symmetry[4, $\partial^{\bullet 4} \sigma^{1 \bullet 2 \bullet 3}$, { $\bullet 1 \rightarrow a, \bullet 2 \rightarrow b, \bullet 3 \rightarrow -a, \bullet 4 \rightarrow -b$ }, StrongGenSet[{1, 2, 4}, GenSet[{-1, 2}]]], {-1, {a, -a, b, -b}}][[{1, 3, 5, 2}]]] == 0	1
$\tau_{1-}^{\#2 \alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\sigma_{1-}^{\#2 \alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} == 0$	3
$\tau_{1+}^{\#1 \alpha\beta} + i k \sigma_{1+}^{\#1 \alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta}$	3
$\sigma_{1+}^{\#1 \alpha\beta} == \sigma_{1+}^{\#2 \alpha\beta}$	$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} == 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}$	3
$\tau_{2+}^{\#1 \alpha\beta} == 0$	$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} == 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \tau^\chi_\chi$	5
$\sigma_{2+}^{\#1 \alpha\beta} == 0$	$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}_\chi == 2 \partial_\delta \partial^\epsilon \partial_\delta \sigma^{\chi\delta}_\chi + 3 (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:		28

Quadratic (free) action

$$S = \iiint (\frac{1}{6} (6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 12 r_1 \partial_\beta \omega_{,\theta} \partial_\theta \omega^{\alpha\beta}_\alpha + 12 r_1 \partial_\theta \omega_{\beta}^\theta \partial_\theta \omega^{\alpha\beta}_\alpha + 12 r_1 \partial_\alpha \omega^{\alpha\beta}_\beta \partial_\theta \omega_{\beta}^\theta - 24 r_1 \partial^\theta \omega^{\alpha\beta}_\alpha \partial_\theta \omega_{\beta}^\theta - 12 r_1 \partial_\alpha \omega^{\alpha\beta}_\beta \partial_\theta \omega_{,\beta}^\theta + 24 r_1 \partial^\theta \omega^{\alpha\beta}_\alpha \partial_\theta \omega_{,\beta}^\theta + 4 t_2 \omega_{,\theta\alpha} \partial^\theta f^{\alpha\chi} + 2 t_2 \partial_\alpha f_{,\theta} \partial^\theta f^{\alpha\chi} - t_2 \partial_\alpha f_{\theta\chi} \partial^\theta f^{\alpha\chi} - t_2 \partial_\theta f_{\alpha\chi} \partial^\theta f^{\alpha\chi} - 4 t_2 \omega_{\alpha\theta\chi} (\omega^{\alpha\chi\theta} + \partial^\theta f^{\alpha\chi}) + 2 t_2 \omega_{\alpha\theta\beta} (\omega^{\alpha\theta\beta} + 2 \partial^\theta f^{\alpha\chi}) - 8 r_1 \partial_\beta \omega_{\alpha\theta} \partial^\theta \omega^{\alpha\beta\chi} + 8 r_2 \partial_\beta \omega_{\alpha\theta\beta} \partial^\theta \omega^{\alpha\beta\chi} + 4 r_1 \partial_\beta \omega_{,\theta\alpha} \partial^\theta \omega^{\alpha\beta\chi} + 4 r_2 \partial_\beta \omega_{,\theta\alpha\beta} \partial^\theta \omega^{\alpha\beta\chi} - 4 r_1 \partial_\theta \omega_{\alpha\beta\theta} \partial^\theta \omega^{\alpha\beta\chi} - 2 r_2 \partial_\theta \omega_{\alpha\beta\theta} \partial^\theta \omega^{\alpha\beta\chi} + 4 r_1 \partial_\theta \omega_{\alpha\beta\chi} \partial^\theta \omega^{\alpha\beta\chi} - 2 r_2 \partial_\theta \omega_{\alpha\beta\chi} \partial^\theta \omega^{\alpha\beta\chi} + 4 r_1 \partial_\theta \omega_{\alpha\beta\chi} \partial^\theta \omega^{\alpha\beta\chi} - 4 r_2 \partial_\theta \omega_{\alpha\beta\chi} \partial^\theta \omega^{\alpha\beta\chi})) [t, x, y, z] dz dy dx dt$$

$\omega_{1+}^{\#1} \tau^{\alpha\beta}$	$\omega_{1+}^{\#2}$	$f_{1+}^{\#1} \tau^{\alpha\beta}$	$\omega_{1-}^{\#1} \omega_{1-}^{\#2} \tau^{\alpha\beta}$	$\omega_{1-}^{\#1} \omega_{1-}^{\#2} \tau^{\alpha\beta}$	$f_{1-}^{\#1} \tau^{\alpha\beta}$	$f_{1-}^{\#2} \tau^{\alpha\beta}$
$\frac{2 t_2}{3}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	0	0	0	0
$\omega_{1+}^{\#2} \tau^{\alpha\beta}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$f_{1+}^{\#1} \tau^{\alpha\beta}$	$-\frac{1}{3} i \sqrt{2} k t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_{1-}^{\#1} \tau^\alpha$	0	0	$-k^2 r_1$	0	0	0
$\omega_{1-}^{\#2} \tau^\alpha$	0	0	0	0	0	0
$f_{1-}^{\#1} \tau^\alpha$	0	0	0	0	0	0
$f_{1-}^{\#2} \tau^\alpha$	0	0	0	0	0	0

$\sigma_{1+}^{\#1} \tau^{\alpha\beta}$	$\sigma_{1+}^{\#2}$	$\tau_{1+}^{\#1} \tau^{\alpha\beta}$	$\sigma_{1-}^{\#1} \sigma_{1-}^{\#2} \tau^{\alpha\beta}$	$\tau_{1-}^{\#1} \tau^{\alpha\beta}$	$\tau_{1-}^{\#2} \tau^{\alpha\beta}$
$\frac{6}{(3+k^2)^2} t_2$	$\frac{3 \sqrt{2}}{(3+k^2)^2} t_2$	$\frac{3 i \sqrt{2} k}{(3+k^2)^2} t_2$	0	0	0
$\sigma_{1+}^{\#2} \tau^{\alpha\beta}$	$\frac{3 \sqrt{2}}{(3+k^2)^2} t_2$	$\frac{3 i k}{(3+k^2)^2} t_2$	0	0	0
$\tau_{1+}^{\#1} \tau^{\alpha\beta}$	$-\frac{3 i \sqrt{2} k}{(3+k^2)^2} t_2$	$\frac{3 k^2}{(3+k^2)^2} t_2$	0	0	0
$\sigma_{1-}^{\#1} \tau^\alpha$	0	0	$-\frac{1}{k^2} r_1$	0	0
$\sigma_{1-}^{\#2} \tau^\alpha$	0	0	0	0	0
$\tau_{1-}^{\#1} \tau^\alpha$	0	0	0	0	0
$\tau_{1-}^{\#2} \tau^\alpha$	0	0	0	0	0

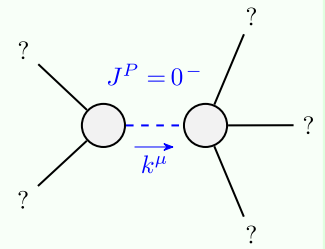
$\sigma_{2+}^{\#1} \tau^{\alpha\beta}$	$\tau_{2+}^{\#1} \tau^{\alpha\beta}$	$\sigma_{2-}^{\#1} \tau^{\alpha\beta\chi}$
0	0	0
$\tau_{2+}^{\#1} \tau^{\alpha\beta}$	0	0
$\sigma_{2-}^{\#1} \tau^{\alpha\beta\chi}$	0	$\frac{1}{k^2} r_1$

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

$\omega_{2+}^{\#1} \tau^{\alpha\beta}$	$f_{2+}^{\#1} \tau^{\alpha\beta}$	$\omega_{2-}^{\#1} \tau^{\alpha\beta\chi}$
0	0	0
$f_{2+}^{\#1} \tau^{\alpha\beta}$	0	0
$\omega_{2-}^{\#1} \tau^{\alpha\beta\chi}$	0	$k^2 r_1$

$\sigma_{0+}^{\#1} \tau^{\alpha\beta}$	$\tau_{0+}^{\#1} \tau^{\alpha\beta}$	$\tau_{0+}^{\#2} \tau^{\alpha\beta}$	$\sigma_{0-}^{\#1} \tau^{\alpha\beta}$
0	0	0	0
$\tau_{0+}^{\#1} \tau^{\alpha\beta}$	0	0	0
$\tau_{0+}^{\#2} \tau^{\alpha\beta}$	0	0	0
$\sigma_{0-}^{\#1} \tau^{\alpha\beta}$	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

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