

Particle spectrograph

Wave operator and propagator

Source constraints		Fundamental fields	Multiplicities
SO(3) irreps			
$\tau_{0+}^{\#2} == 0$		$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{0+}^{\#1} == 0$		$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1
$\tau_{1-}^{\#2\alpha} == 0$		$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#1\alpha\beta} == 0$		$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + \partial_\beta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha} == \partial_\chi \partial^\alpha \tau^\chi_\beta + \partial_\chi \partial^\beta \tau^\alpha_\chi + \partial_\chi \partial^\chi \tau^{\beta\alpha} + \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta}$	3
$\sigma_{1+}^{\#1\alpha\beta} == \sigma_{1+}^{\#2\alpha\beta}$		$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^\chi_\chi + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} == 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}$	3
$\tau_{2+}^{\#1\alpha\beta} == 0$		$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \partial^\alpha \tau^\chi_\chi + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 2 \eta^{\alpha\beta} \partial_\varepsilon \partial^\varepsilon \partial_\delta \partial_\chi \tau^{\chi\delta} == 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 2 \eta^{\alpha\beta} \partial_\varepsilon \partial^\varepsilon \partial_\delta \partial_\chi \tau^{\chi\delta}$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$		$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \eta^{\alpha\beta} \partial_\varepsilon \partial^\varepsilon \partial_\delta \sigma^{\chi\delta} == 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\delta} + 3 (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:			27

Quadratic (free) action

$$S = \iiint \iiint \Big(\frac{1}{6} \tau_{\alpha\beta} f^{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 12 r_1 \partial_\beta \omega^{\theta}_{\alpha} \partial' \omega^{\alpha\beta}_{\theta} + 24 r_3 \partial_\beta \omega^{\theta}_{\alpha} \partial' \omega^{\alpha\beta}_{\theta} + 12 r_1 \partial_\alpha \omega^{\alpha\beta\iota}_{\beta} \partial_\theta \omega^{\theta}_{\beta} - 24 r_1 \partial' \omega^{\alpha\beta}_{\alpha} \partial_\theta \omega^{\theta}_{\beta} + 12 r_1 \partial_\alpha \omega^{\alpha\beta\iota}_{\beta} \partial_\theta \omega^{\theta}_{\beta} - 24 r_3 \partial_\alpha \omega^{\alpha\beta\iota}_{\beta} \partial_\theta \omega^{\theta}_{\beta} + 24 r_1 \partial' \omega^{\alpha\beta}_{\alpha} \partial_\theta \omega^{\theta}_{\beta} + 48 r_3 \partial' \omega^{\alpha\beta}_{\alpha} \partial_\theta \omega^{\theta}_{\beta} + 4 t_2 \omega_{\theta\alpha} \partial^\theta f^{\alpha\iota} + 2 t_2 \partial_\alpha f_{\theta\iota} \partial^\theta f^{\alpha\iota} - t_2 \partial_\alpha f_{\theta\iota} \partial^\theta f^{\alpha\iota} - t_2 \partial_\iota f_{\alpha\theta} \partial^\theta f^{\alpha\iota} + t_2 \partial_\theta f_{\alpha\iota} \partial^\theta f^{\alpha\iota} - t_2 \partial_\theta f_{\iota\alpha} \partial^\theta f^{\alpha\iota} - 4 t_2 \omega_{\alpha\theta\iota} (\omega^{\alpha\iota\theta} + \partial^\theta f^{\alpha\iota}) + 2 t_2 \omega_{\alpha\iota\theta} (\omega^{\alpha\iota\theta} + 2 \partial^\theta f^{\alpha\iota}) - 8 r_1 \partial_\beta \omega_{\alpha\iota\theta} \partial^\theta \omega^{\alpha\beta\iota} + 8 r_2 \partial_\beta \omega_{\alpha\iota\theta} \partial^\theta \omega^{\alpha\beta\iota} + 4 r_1 \partial_\beta \omega_{\alpha\theta\iota} \partial^\theta \omega^{\alpha\beta\iota} - 4 r_2 \partial_\beta \omega_{\alpha\theta\iota} \partial^\theta \omega^{\alpha\beta\iota} + 8 r_1 \partial_\beta \omega_{\iota\theta\alpha} \partial^\theta \omega^{\alpha\beta\iota} + 4 r_2 \partial_\beta \omega_{\iota\theta\alpha} \partial^\theta \omega^{\alpha\beta\iota} - 24 r_3 \partial_\beta \omega_{\iota\theta\alpha} \partial^\theta \omega^{\alpha\beta\iota} - 4 r_1 \partial_\iota \omega_{\alpha\beta\theta} \partial^\theta \omega^{\alpha\beta\iota} - 2 r_2 \partial_\iota \omega_{\alpha\beta\theta} \partial^\theta \omega^{\alpha\beta\iota} + 4 r_1 \partial_\theta \omega_{\alpha\beta\iota} \partial^\theta \omega^{\alpha\beta\iota} + 2 r_2 \partial_\theta \omega_{\alpha\beta\iota} \partial^\theta \omega^{\alpha\beta\iota} + 4 r_1 \partial_\theta \omega_{\alpha\beta\iota} \partial^\theta \omega^{\alpha\beta\iota} - 4 r_2 \partial_\theta \omega_{\alpha\iota\beta} \partial^\theta \omega^{\alpha\beta\iota}) [t, x, y, z] dz dy dx dt$$

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

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

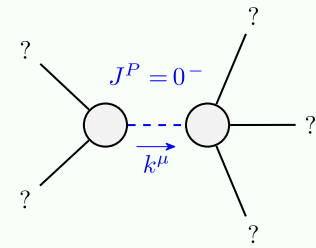
$\omega_0^{\#1} \dagger$	$f_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_0^{\#1}$
$6 k^2 (-r_1 + r_3)$	0	0	$\frac{1}{6 k^2 (-r_1 + r_3)}$
$f_{0+}^{\#1} \dagger$	0	0	0
$f_{0+}^{\#2} \dagger$	0	0	0
$\omega_0^{\#1} \dagger$	0	0	$\frac{1}{k^2 r_2 + t_2}$

$\sigma_0^{\#1} \dagger$	$\tau_0^{\#1}$	$\tau_0^{\#2}$	$\sigma_0^{\#1}$
0	0	0	0
$\sigma_0^{\#1} \dagger$	0	0	$\frac{1}{k^2 r_2 + t_2}$

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

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

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 (sawtooth)

Unitarity conditions

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