

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
$\tau_{0+}^{\#1} - 2 \, i \, k \, \sigma_{0+}^{\#1} == 0$			$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha + 2 \, \partial_\chi \partial^\chi \partial_\beta \sigma^{\alpha\beta}_\alpha$	1
$\tau_{1-}^{\#2\alpha} + 2 \, i \, k \, \sigma_{1-}^{\#2\alpha} == 0$			$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta} + 2 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	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
$\tau_{1+}^{\#1\alpha\beta} + i \, k \, \sigma_{1+}^{\#1\alpha\beta} == 0$			$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^\chi_\alpha + \partial_\chi \partial^\chi \tau^{\alpha\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha} == \partial_\chi \partial^\alpha \tau^\chi_\beta + \partial_\chi \partial^\beta \tau^\alpha_\chi + \partial_\chi \partial^\chi \tau^{\beta\alpha} + \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta}$	3
$\sigma_{1+}^{\#1\alpha\beta} == \sigma_{1+}^{\#2\alpha\beta}$			$3 \, \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2 \, \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \, \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} == 2 \, \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} + 3 \, \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}$	3
$\tau_{2+}^{\#1\alpha\beta} == 0$			$4 \, \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \, \partial_\delta \partial^\delta \partial_\beta \partial^\alpha \tau^\chi_\chi + 3 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\alpha\beta} + 3 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\alpha\chi} + 3 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\chi\alpha} + 2 \, \eta^{\alpha\beta} \, \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} == 3 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\alpha\chi} + 3 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\alpha\chi\beta} + 3 \, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \tau^{\chi\alpha} + 2 \, \eta^{\alpha\beta} \, \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta}$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$			$3 \, \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \, \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \, \eta^{\alpha\beta} \, \partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}_\chi == 2 \, \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\delta} + 3 \, (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:				24

Quadratic (free) action

$$S == \int \int \int \int (\frac{1}{6} (-4 \, t_3 \, \omega^\alpha_\alpha \, \omega^\kappa_{\, \, \kappa} + 6 \, f^{\alpha\beta} \, \tau_{\alpha\beta} + 6 \, \omega^{\alpha\beta\chi} \, \sigma_{\alpha\beta\chi} + 8 \, t_3 \, \omega^\kappa_\alpha \, \omega^\kappa_\kappa \, \partial_\iota f^{\alpha\iota} - 8 \, t_3 \, \omega^\kappa_{\, \, \kappa} \, \partial_\iota f^\alpha_\alpha + 4 \, t_3 \, \partial_\iota f^\kappa_\kappa \, \partial_\iota f^\alpha_\alpha - 12 \, r_1 \, \partial_\beta \omega^\theta_{\, \, \theta} \, \partial_\iota \omega^{\alpha\beta}_\alpha + 12 \, r_1 \, \partial_\iota \omega^\theta_\beta \, \partial_\iota \omega^{\alpha\beta}_\alpha + 12 \, r_1 \, \partial_\alpha \omega^{\alpha\beta}_\beta - 12 \, r_1 \, \partial_\alpha \omega^{\alpha\beta\iota} \, \partial_\theta \omega^\theta_{\, \, \beta} - 24 \, r_1 \, \partial_\iota \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_{\iota\theta} \, \partial^\theta f^{\alpha\iota} - 24 \, r_1 \, \partial_\iota \omega^{\alpha\beta}_\beta \, \partial^\theta \omega^\theta_{\, \, \alpha} \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_{\alpha\iota} \, \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} - 16 \, 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} - 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\iota\beta} \, \partial^\theta \omega^{\alpha\beta\iota} - 4 \, r_2 \, \partial_\theta \omega_{\alpha\iota\beta} \, \partial^\theta \omega^{\alpha\beta\iota} + 4 \, t_3 \, \partial_\iota f^{\alpha\iota} \, \partial_\kappa f^\kappa_\alpha - 8 \, t_3 \, \partial_\iota f^\alpha_\alpha \, \partial_\kappa f^\kappa_\iota)) [t, \, x, \, y, \, z] d^3z \, dy \, dx \, dt$$

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2}$	$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1-}^{\#1}$	$\sigma_{1-}^{\#2}$	$\tau_{1-}^{\#1}$	$\tau_{1-}^{\#2}$
$\frac{6}{(3+k^2)^2} t_2$	$\frac{3 \sqrt{2}}{(3+k^2)^2} t_2$	$\frac{3 i \sqrt{2} k}{(3+k^2)^2} t_2$	0	0	0	0
$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$\frac{3 \sqrt{2}}{(3+k^2)^2} t_2$	$\frac{3 i k}{(3+k^2)^2} t_2$	0	0	0	0
$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{3 i \sqrt{2} k}{(3+k^2)^2} t_2$	$\frac{3 k^2}{(3+k^2)^2} t_2$	0	0	0	0
$\sigma_{1-}^{\#1} \dagger^\alpha$	0	0	$-\frac{1}{k^2} r_1$	$-\frac{\sqrt{2}}{k^2 r_1 + 2 k^4} r_1$	0	$-\frac{2 i}{k r_1 + 2 k^3} r_1$
$\sigma_{1-}^{\#2} \dagger^\alpha$	0	0	$-\frac{\sqrt{2}}{k^2 r_1 + 2 k^4} r_1$	$\frac{3 k^2 r_1 - 2 t_3}{(k + 2 k^3)^2} r_1 t_3$	0	$\frac{i \sqrt{2} (3 k^2 r_1 - 2 t_3)}{k (1 + 2 k^2)^2} r_1 t_3$
$\tau_{1-}^{\#1} \dagger^\alpha$	0	0	0	0	0	0
$\tau_{1-}^{\#2} \dagger^\alpha$	0	0	$\frac{2 i}{k r_1 + 2 k^3} r_1$	$-\frac{i \sqrt{2} (3 k^2 r_1 - 2 t_3)}{k (1 + 2 k^2)^2} r_1 t_3$	0	$\frac{6 k^2 r_1 - 4 t_3}{(1 + 2 k^2)^2} r_1 t_3$

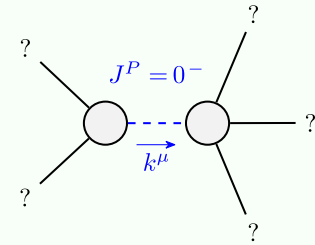
$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2}$	$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1-}^{\#1}$	$\omega_{1-}^{\#2}$	$f_{1-}^{\#1}$	$f_{1-}^{\#2}$
$\frac{2 t_2}{3}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	0	0	0	0
$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	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	$-k^2 r_1 + \frac{2 t_3}{3}$	$-\frac{\sqrt{2} t_3}{3}$	0	$-\frac{2}{3} i k t_3$
$\omega_{1-}^{\#2} \dagger^\alpha$	0	0	$-\frac{\sqrt{2} t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3} i \sqrt{2} k t_3$
$f_{1-}^{\#1} \dagger^\alpha$	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger^\alpha$	0	0	$\frac{2 i k t_3}{3}$	$-\frac{1}{3} i \sqrt{2} k t_3$	0	$\frac{2 k^2 t_3}{3}$

$\sigma_{0+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\frac{1}{(1+2 k^2)^2} t_3$	$-\frac{i \sqrt{2} k}{(1+2 k^2)^2} t_3$	0	0	0
$\tau_{0+}^{\#1} \dagger^{\alpha\beta}$	$\frac{i \sqrt{2} k}{(1+2 k^2)^2} t_3$	$\frac{2 k^2}{(1+2 k^2)^2} t_3$	0	0
$\tau_{0+}^{\#2} \dagger^{\alpha\beta}$	0	0	0	0
$\sigma_{0-}^{\#1} \dagger^{\alpha\beta}$	0	0	$k^2 r_2 + t_2$	$\frac{1}{k^2 r_2 + t_2}$

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

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

Unitarity conditions

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