

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
$\tau_{0+}^{\#1} - 2 \, i \, k \, \sigma_{0+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha + 2 \, \partial_\chi \partial^\chi \partial_\beta \sigma^{\alpha\beta}_\alpha$	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
$\tau_1^{\#1\,\alpha\beta} + i \, k \, \sigma_1^{\#2\,\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} +$ $2 \, \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2 \, \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} +$ $\partial_\chi \partial^\chi \tau^{\beta\alpha} + 2 \, \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\tau_2^{\#1\,\alpha\beta} - 2 \, i \, k \, \sigma_2^{\#1\,\alpha\beta} == 0$	$-i \, (4 \, \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \, \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi -$ $3 \, \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3 \, \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3 \, \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} - 3 \, \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $3 \, \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3 \, \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $4 \, i \, k^\chi \, \partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta -$ $6 \, i \, k^\chi \, \partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon} -$ $6 \, i \, k^\chi \, \partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} +$ $2 \, \eta^{\alpha\beta} \, \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} +$ $6 \, i \, k^\chi \, \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta} +$ $6 \, i \, k^\chi \, \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha} -$ $2 \, \eta^{\alpha\beta} \, \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi_\chi -$ $4 \, i \, \eta^{\alpha\beta} \, k^\chi \, \partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5
Total constraints/gauge generators:		16

Quadratic (free) action

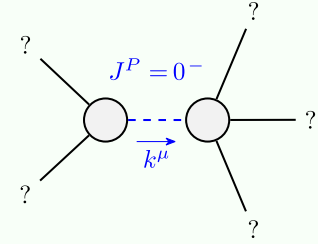
$$S == \int \int \int \int (\frac{1}{6} (2 \, t_1 \, \omega^\alpha_\alpha \, \omega^\theta_{\theta'} - 4 \, t_3 \, \omega^\alpha_{\alpha'} \, \omega^\kappa_{\kappa'} +$$
  
$$6 \, f^{\alpha\beta} \, \tau_{\alpha\beta} + 6 \, \omega^{\alpha\beta\chi} \, \sigma_{\alpha\beta\chi} - 4 \, t_1 \, \omega^\theta_{\alpha} \, \omega^\theta_{\beta'} \, \partial_\beta f^{\alpha\alpha'} +$$
  
$$8 \, t_3 \, \omega^\kappa_{\alpha} \, \omega^\kappa_{\beta'} \, \partial_\beta f^{\alpha\alpha'} + 4 \, t_1 \, \omega^\theta_{\beta'} \, \partial_\beta f^\alpha_{\alpha'} - 8 \, t_3 \, \omega^\kappa_{\beta'} \, \partial_\beta f^\alpha_{\alpha'} -$$
  
$$2 \, t_1 \, \partial_\beta f^\theta_{\theta'} \, \partial_\beta f^\alpha_{\alpha'} + 4 \, t_3 \, \partial_\beta f^\kappa_{\kappa'} \, \partial_\beta f^\alpha_{\alpha'} - 2 \, t_1 \, \partial_\beta f^{\alpha\alpha'} \, \partial_\beta f^\theta_{\theta'} +$$
  
$$4 \, t_1 \, \partial_\beta f^\alpha_{\alpha'} \, \partial_\beta f^\theta_{\theta'} + 4 \, t_1 \, \omega_{\theta\alpha} \, \partial^\theta f^{\alpha\alpha'} + 4 \, t_2 \, \omega_{\theta\alpha} \, \partial^\theta f^{\alpha\alpha'} -$$
  
$$4 \, t_1 \, \partial_\alpha f_{\beta'} \partial^\theta f^{\alpha\beta'} + 2 \, t_2 \, \partial_\alpha f_{\beta'} \partial^\theta f^{\alpha\beta'} - 4 \, t_1 \, \partial_\alpha f_{\theta'} \partial^\theta f^{\alpha\theta'} -$$
  
$$t_2 \, \partial_\alpha f_{\theta'} \partial^\theta f^{\alpha\theta'} + 2 \, t_1 \, \partial_\beta f_{\alpha\theta'} \partial^\theta f^{\alpha\theta'} - t_2 \, \partial_\beta f_{\alpha\theta'} \partial^\theta f^{\alpha\theta'} +$$
  
$$4 \, t_1 \, \partial_\theta f_{\alpha'} \partial^\theta f^{\alpha\alpha'} + t_2 \, \partial_\theta f_{\alpha'} \partial^\theta f^{\alpha\alpha'} + 2 \, t_1 \, \partial_\theta f_{\beta'} \partial^\theta f^{\alpha\beta'} -$$
  
$$t_2 \, \partial_\theta f_{\beta'} \partial^\theta f^{\alpha\beta'} + 2 \, (t_1 + t_2) \, \omega_{\alpha\theta} \, ( \, \omega^{\alpha\theta} + 2 \, \partial^\theta f^{\alpha\theta'} ) +$$
  
$$2 \, \omega_{\alpha\theta'} \, ((t_1 - 2 \, t_2) \, \omega^{\alpha\theta} + 2 \, (2 \, t_1 - t_2) \, \partial^\theta f^{\alpha\theta'} ) +$$
  
$$8 \, r_2 \, \partial_\beta \omega_{\alpha\theta} \partial^\theta \omega^{\alpha\beta\theta'} - 4 \, r_2 \, \partial_\beta \omega_{\alpha\theta'} \partial^\theta \omega^{\alpha\beta\theta'} +$$
  
$$4 \, r_2 \, \partial_\beta \omega_{\theta\alpha} \partial^\theta \omega^{\alpha\beta\theta'} - 2 \, r_2 \, \partial_\beta \omega_{\alpha\theta\theta'} \partial^\theta \omega^{\alpha\beta\theta'} +$$
  
$$2 \, r_2 \, \partial_\theta \omega_{\alpha\beta\theta'} \partial^\theta \omega^{\alpha\beta\theta'} - 4 \, r_2 \, \partial_\theta \omega_{\alpha\beta\theta'} \partial^\theta \omega^{\alpha\beta\theta'} +$$
  
$$4 \, t_3 \, \partial_\beta f^{\alpha\alpha'} \partial_\alpha f^\kappa_{\kappa'} - 8 \, t_3 \, \partial_\beta f^\alpha_{\alpha'} \, \partial_\alpha f^{\kappa\kappa'} ) [t, \, x, \, y, \, z] \, dz \, dy \, dx \, dt$$

$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_0^{\#1}$
$\frac{1}{(1+2\,k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	0	0
$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_3}$	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2\,r_2+t_2}$

$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1-}^{\#1} \dagger_\alpha$	$\omega_{1-}^{\#2} \dagger_\alpha$	$f_{1-}^{\#1} \dagger_\alpha$	$f_{1-}^{\#2} \dagger_\alpha$
$\frac{1}{6} \, (t_1 + 4 \, t_2)$	$-\frac{t_1-2\,t_2}{3 \, \sqrt{2}}$	$-\frac{i \, k \, (t_1-2\,t_2)}{3 \, \sqrt{2}}$	0	0	0	0
$\frac{-t_1-2\,t_2}{3 \, \sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3} \, i \, k \, (t_1 + t_2)$	0	0	0	0
$\frac{i \, k \, (t_1-2\,t_2)}{3 \, \sqrt{2}}$	$-\frac{1}{3} \, i \, k \, (t_1 + t_2)$	$\frac{1}{3} \, k^2 \, (t_1 + t_2)$	0	0	0	0
0	0	0	$\frac{1}{6} \, (t_1 + 4 \, t_3)$	$\frac{t_1-2\,t_3}{3 \, \sqrt{2}}$	0	$\frac{1}{3} \, i \, k \, (t_1 - 2 \, t_3)$
0	0	0	$\frac{t_1-2\,t_3}{3 \, \sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$\frac{1}{3} \, i \, \sqrt{2} \, k \, (t_1 + t_3)$
0	0	0	0	0	0	0
0	0	0	$-\frac{1}{3} \, i \, k \, (t_1 - 2 \, t_3)$	$-\frac{1}{3} \, i \, \sqrt{2} \, k \, (t_1 + t_3)$	0	$\frac{2}{3} \, k^2 \, (t_1 + t_3)$

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1-}^{\#1} \dagger_\alpha$	$\sigma_{1-}^{\#2} \dagger_\alpha$	$\tau_{1-}^{\#1} \dagger_\alpha$	$\tau_{1-}^{\#2} \dagger_\alpha$
$\frac{i \, \sqrt{2} \, k \, (t_1-2\,t_2)}{3 \, (1+k^2) \, t_1 \, t_2}$	$\frac{\sqrt{2} \, (t_1-2\,t_2)}{3 \, (1+k^2) \, t_1 \, t_2}$	$\frac{i \, k \, (t_1+4\,t_2)}{3 \, (1+k^2)^2 \, t_1 \, t_2}$	0	0	0	0
$\frac{\sqrt{2} \, (t_1-2\,t_2)}{3 \, (1+k^2) \, t_1 \, t_2}$	$\frac{t_1+4\,t_2}{3 \, (1+k^2)^2 \, t_1 \, t_2}$	$\frac{i \, k \, (t_1+4\,t_2)}{3 \, (1+k^2)^2 \, t_1 \, t_2}$	0	0	0	0
$-\frac{i \, \sqrt{2} \, k \, (t_1-2\,t_2)}{3 \, (1+k^2) \, t_1 \, t_2}$	$-\frac{i \, k \, (t_1+4\,t_2)}{3 \, (1+k^2)^2 \, t_1 \, t_2}$	$\frac{k^2 \, (t_1+4\,t_2)}{3 \, (1+k^2)^2 \, t_1 \, t_2}$	0	0	0	0
0	0	0	$\frac{2 \, (t_1+t_3)}{3 \, t_1 \, t_3}$	$-\frac{\sqrt{2} \, (t_1-2\,t_3)}{3 \, (1+2 \, k^2) \, t_1 \, t_3}$	0	$-\frac{2 \, i \, k \, t_1-4 \, i \, k \, t_3}{3 \, t_1 \, t_3 + 6 \, k^2 \, t_1 \, t_3}$
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

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

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