

Particle spectrograph

Wave operator and propagator

Source constraints			
SO(3) irreps	Fundamental fields	Multiplicities	
$\sigma_0^{\#1} == 0$	$\epsilon \eta_{\alpha\beta\chi\delta} \partial^\delta \sigma^{\alpha\beta\chi} == 0$	1	
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	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	
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi}$	3	
$\tau_{2+}^{\#1\alpha\beta} - 2 i k \sigma_{2+}^{\#1\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\alpha} + 2 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	5	
	$-i (4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi - 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 4 i k^\chi \partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta - 6 i k^\chi \partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}_\delta - 6 i k^\chi \partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}_\epsilon + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} + 6 i k^\chi \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta}_\beta + 6 i k^\chi \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha}_\alpha - 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^{\chi\chi}_\chi - 4 i \eta^{\alpha\beta} k^\chi \partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$		
Total constraints/gauge generators:			17

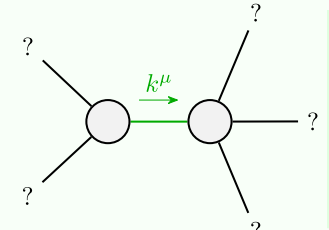
$\sigma_{1+}^{\#1} + \alpha\beta$	$\sigma_{1+}^{\#2} + \alpha\beta$	$\tau_{1+}^{\#1} + \alpha\beta$	$\sigma_{1-}^{\#1} - \alpha$	$\sigma_{1-}^{\#2} - \alpha$	$\tau_{1-}^{\#1} - \alpha$	$\tau_{1-}^{\#2} - \alpha$
$\frac{1}{k^2 r_5}$	$\frac{1}{\sqrt{2} (k^2 r_5 + k^4 r_5)}$	$\frac{i}{\sqrt{2} (k r_5 + k^3 r_5)}$	0	0	0	0
$\frac{1}{\sqrt{2} (k^2 r_5 + k^4 r_5)}$	$\frac{6 k^2 r_5 + t_1}{2 (k + k^3)^2 r_5 t_1}$	$\frac{i (6 k^2 r_5 + t_1)}{2 k (1 + k^2)^2 r_5 t_1}$	0	0	0	0
$-\frac{i}{\sqrt{2} (k r_5 + k^3 r_5)}$	$-\frac{i (6 k^2 r_5 + t_1)}{2 k (1 + k^2)^2 r_5 t_1}$	$\frac{6 k^2 r_5 + t_1}{2 (1 + k^2)^2 r_5 t_1}$	0	0	0	0
0	0	0	0	$\frac{\sqrt{2}}{t_1 + 2 k^2 t_1}$	0	$\frac{2 i k}{t_1 + 2 k^2 t_1}$
0	0	0	$\frac{\sqrt{2}}{t_1 + 2 k^2 t_1}$	$\frac{-2 k^2 r_5 + t_1}{(t_1 + 2 k^2 t_1)^2}$	0	$-\frac{i \sqrt{2} k (2 k^2 r_5 + t_1)}{(t_1 + 2 k^2 t_1)^2}$
0	0	0	0	0	0	0
0	0	0	$-\frac{2 i k}{t_1 + 2 k^2 t_1}$	$\frac{i \sqrt{2} k (2 k^2 r_5 + t_1)}{(t_1 + 2 k^2 t_1)^2}$	0	$\frac{-4 k^4 r_5 + 2 k^2 t_1}{(t_1 + 2 k^2 t_1)^2}$

Quadratic (free) action

$$S == \iiint (f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \frac{1}{3} t_1 (3 \omega^{\alpha\iota}_\alpha \omega^{\theta}_{\iota\theta} - 6 \omega^{\theta}_{\alpha\theta} \partial_{\iota} f^{\alpha\iota} + 6 \omega^{\iota}_{\theta\theta} \partial^{\iota} f^{\alpha}_{\alpha} - 3 \partial_{\iota} f^{\theta}_{\theta} \partial^{\iota} f^{\alpha}_{\alpha} - 3 \partial_{\iota} f^{\alpha\iota} \partial_{\theta} f^{\theta}_{\alpha} + 6 \partial^{\iota} f^{\alpha}_{\alpha} \partial_{\theta} f^{\theta}_{\iota} + 2 \omega_{\iota\theta\alpha} \partial^{\theta} f^{\alpha\iota} - 2 \partial_{\alpha} f_{\iota\theta} \partial^{\theta} f^{\alpha\iota} - 2 \partial_{\alpha} f_{\theta\iota} \partial^{\theta} f^{\alpha\iota} + \partial_{\iota} f_{\alpha\theta} \partial^{\theta} f^{\alpha\iota} + 2 \partial_{\theta} f_{\alpha\iota} \partial^{\theta} f^{\alpha\iota} + \partial_{\theta} f_{\iota\alpha} \partial^{\theta} f^{\alpha\iota}) + \omega_{\alpha\iota\theta} (\omega^{\alpha\iota\theta} + 2 \partial^{\theta} f^{\alpha\iota}) + \omega_{\alpha\theta\iota} (\omega^{\alpha\iota\theta} + 4 \partial^{\theta} f^{\alpha\iota})) + r_5 (\partial_{\iota} \omega^{\kappa}_{\theta\kappa} \partial^{\theta} \omega^{\alpha\iota}_{\alpha} - \partial_{\theta} \omega^{\kappa}_{\alpha\kappa} \partial^{\theta} \omega^{\alpha\iota}_{\iota} - \partial_{\alpha} \omega^{\alpha\iota\theta} - 2 \partial^{\theta} \omega^{\alpha\iota}_{\alpha}) (\partial_{\kappa} \omega^{\kappa}_{\iota\theta} - \partial_{\kappa} \omega^{\kappa}_{\theta\iota})) [t, x, y, z] dz dy dx dt$$

$\omega_{0+}^{\#1} +$	$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_{0-}^{\#1}$
$\tau_{0+}^{\#1} +$	$-t_1$	$i \sqrt{2} k t_1$	0	0
$f_{0+}^{\#1} +$	$-i \sqrt{2} k t_1$	$-2 k^2 t_1$	0	0
$f_{0+}^{\#2} +$	0	0	0	0
$\omega_{0-}^{\#1} +$	0	0	0	0
$\omega_{2+}^{\#1} + \alpha\beta$	$\frac{t_1}{2}$	$-\frac{i k t_1}{\sqrt{2}}$	0	
$f_{2+}^{\#1} + \alpha\beta$	$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0	
$\omega_{2-}^{\#1} + \alpha\beta\chi$	0	0	$\frac{t_1}{2}$	
$\sigma_{0+}^{\#1} +$	$-\frac{1}{(1+2k^2)^2 t_1}$	$\frac{i \sqrt{2} k}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0+}^{\#1} +$	$-\frac{i \sqrt{2} k}{(1+2k^2)^2 t_1}$	$-\frac{2 k^2}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0+}^{\#2} +$	0	0	0	0
$\sigma_{0-}^{\#1} +$	0	0	0	0
$\sigma_{2+}^{\#1} + \alpha\beta$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2 i \sqrt{2} k}{(1+2k^2)^2 t_1}$	0	
$\tau_{2+}^{\#1} + \alpha\beta$	$\frac{2 i \sqrt{2} k}{(1+2k^2)^2 t_1}$	$\frac{4 k^2}{(1+2k^2)^2 t_1}$	0	
$\sigma_{2-}^{\#1} + \alpha\beta\chi$	0	0	$\frac{2}{t_1}$	

Massive and massless spectra



Quadratic pole

Pole residue: $\frac{1}{r_5 t_1^2 p^2} > 0$

Polarisations: 2

(No massive particles)

Unitarity conditions

$r_5 > 0 \ \&\& \ t_1 < 0 \ || \ t_1 > 0$