

Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{a\beta} == 0$	1
$\tau_{0+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{a\beta} == \partial_\beta \partial_\beta \tau^a_\alpha$	1
$\sigma_{0+}^{\#1} == 0$	$\partial_\beta \sigma^{a\beta}_\alpha == 0$	1
$\tau_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{a\beta}$	3
$\tau_{1-}^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{l\alpha}$	3
$\sigma_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{a\beta\chi} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i l k \sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{a\beta} +$ $2 \partial_\theta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2 \partial_\theta \partial^\delta \partial_\chi \sigma^{a\beta\chi} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} +$ $\partial_\chi \partial^\chi \tau^{l\beta\alpha} + 2 \partial_\beta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	$3 \partial_\epsilon \partial_\beta \partial^\chi \partial^\beta \sigma^{l\delta\epsilon} + 3 \partial_\epsilon \partial^\epsilon \partial_\chi \partial^\alpha \sigma^{l\beta\delta}_\delta +$ $2 \partial_\epsilon \partial^\epsilon \partial_\theta \partial^\beta \sigma^{\alpha\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\beta \partial^\beta \sigma^{\alpha\delta\chi} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\theta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\beta \partial^\chi \sigma^{\alpha\beta\delta} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\theta \partial^\chi \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\beta \partial^\beta \sigma^{\beta\chi\alpha} +$ $3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\alpha \sigma^{\delta\epsilon}_\delta +$ $3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial_\delta \sigma^{l\beta\delta\epsilon} +$ $3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\alpha \sigma^{\alpha\delta}_\delta ==$ $3 \partial_\epsilon \partial_\theta \partial_\beta \partial^\chi \partial^\beta \sigma^{\alpha\delta\epsilon} + 3 \partial_\epsilon \partial^\epsilon \partial_\chi \partial^\beta \sigma^{\alpha\delta}_\delta +$ $2 \partial_\epsilon \partial^\epsilon \partial_\theta \partial^\beta \sigma^{\beta\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\beta \partial^\beta \sigma^{\delta\beta\chi} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\theta \partial^\beta \sigma^{\chi\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\beta \partial^\chi \sigma^{\beta\delta\alpha} +$ $4 \partial_\epsilon \partial^\epsilon \partial_\theta \partial^\beta \sigma^{a\beta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\beta \partial^\beta \sigma^{\alpha\chi\beta} +$ $3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\beta \sigma^{\delta\epsilon}_\delta +$ $3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial_\delta \sigma^{a\delta\epsilon} +$ $3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\delta \sigma^{l\beta\delta}_\delta$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	$4 \partial_\beta \partial_\chi \partial^\beta \partial^\alpha \tau^{\alpha\chi\delta} + 2 \partial_\beta \partial^\delta \partial^\beta \tau^{\alpha\chi}_\chi +$ $3 \partial_\theta \partial^\delta \partial_\chi \partial_\tau^{\chi\alpha\beta} + 3 \partial_\theta \partial^\delta \partial_\chi \partial^\chi \tau^{l\beta\alpha} +$ $2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\theta \partial_\chi \tau^{\chi\delta} ==$ $3 \partial_\theta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\theta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} +$ $3 \partial_\theta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} + 3 \partial_\theta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $2 \eta^{\alpha\beta} \partial_\epsilon \partial_\theta \partial^\delta \tau^{\chi\chi}_\chi$	5
Total constraints/gauge generators:		25

Quadratic (free) action	
S== $\iiint\iiint\big(\frac{1}{6} f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{a\beta\chi} \sigma_{a\beta\chi} - 3 r_3 \partial_\beta \omega^{a\theta}_{\theta} \partial_l \omega^{a\beta}_\alpha - 3 r_3 \partial_l \omega^{a\beta}_\beta \partial_\theta \omega^{a\beta}_\alpha - 3 r_3 \partial_\alpha \omega^{a\beta l} \partial_\theta \omega^{a\beta}_{\beta} + 6 r_3 \partial_l \omega^{a\beta}_\alpha \partial_\theta \omega^{a\beta}_{\beta} - 3 r_3 \partial_\alpha \omega^{a\beta l} \partial_\theta \omega^{a\beta}_{\beta} + 6 r_3 \partial_l \omega^{a\beta}_\alpha \partial_\theta \omega^{a\beta}_{\beta} + 4 t_2 \omega_{l\theta\alpha} \partial^\theta f^{a\chi} + 2 t_2 \partial_{a\ell} f_{l\theta} \partial^\theta f^{a\chi} - t_2 \partial_{a\ell} f_{l\alpha} \partial^\theta f^{a\chi} - t_2 \partial_l f_{\alpha\theta} \partial^\theta f^{a\chi} + t_2 \partial_{\theta\ell} f_{a\chi} \partial^\theta f^{a\chi} - t_2 \partial_{\theta\ell} f_{l\alpha} \partial^\theta f^{a\chi} - 4 t_2 \omega_{a\theta l} (\omega^{a l \theta} + \partial^\theta f^{a l}) + 2 t_2 \omega_{a l \theta} (\omega^{a l \theta} + 2 \partial^\theta f^{a l}) + 8 r_2 \partial_\beta \omega_{a l \theta} \partial^\theta \omega^{a \beta l} - 4 r_2 \partial_\beta \omega_{a \theta l} \partial^\theta \omega^{a \beta l} + 4 r_2 \partial_\beta \omega_{l \theta \alpha} \partial^\theta \omega^{a \beta l} - 24 r_3 \partial_\beta \omega_{l \theta \alpha} \partial^\theta \omega^{a \beta l} - 2 r_2 \partial_l \omega_{a \beta \theta} \partial^\theta \omega^{a \beta l} + 2 r_2 \partial_\theta \omega_{a \beta l} \partial^\theta \omega^{a \beta l} - 4 r_2 \partial_\theta \omega_{a l \beta} \partial^\theta \omega^{a \beta l} + 6 r_5 \partial_l \omega^{a l}_{\theta} \partial^\theta \omega^{a l}_{\alpha} - 6 r_5 \partial_\alpha \omega^{a l}_{\theta} \partial^\theta \omega^{a l}_{\beta} + 12 r_5 \partial^\theta \omega^{a l}_{\alpha} \partial_\alpha \omega^{a l}_{\beta} + 6 r_5 \partial_\alpha \omega^{a l \theta} \partial_\beta \omega^{a l}_{\theta} - 12 r_5 \partial^\theta \omega^{a l}_{\alpha} \partial_\alpha \omega^{a l}_{\beta}) [t, x, y, z] dz dy dx dt$	

$\sigma_{1+}^{\#1} \tau_{1+}^{\alpha\beta}$	$\sigma_{1+}^{\#2} \tau_{1+}^{\alpha\beta}$	$\tau_{1+}^{\#1} \tau_{1+}^{\alpha\beta}$	$\sigma_{1-}^{\#1} \tau_{1-}^{\alpha\beta}$	$\sigma_{1-}^{\#2} \tau_{1-}^{\alpha\beta}$	$\tau_{1-}^{\#1} \tau_{1-}^{\alpha\beta}$
$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$-\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	0	0	0
$-\frac{\sqrt{2}}{k^2(1+k^2)(2r_3+r_5)}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(k+k^3)^2(2r_3+r_5)t_2}$	$\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0
$\frac{i\sqrt{2}}{k(1+k^2)(2r_3+r_5)}$	$-\frac{i(3k^2(2r_3+r_5)+2t_2)}{k(1+k^2)^2(2r_3+r_5)t_2}$	$\frac{3k^2(2r_3+r_5)+2t_2}{(1+k^2)^2(2r_3+r_5)t_2}$	0	0	0
0	0	0	$\frac{2}{k^2(r_3+2r_5)}$	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

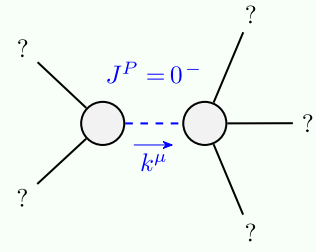
$\omega_{1+}^{\#1} \tau_{1+}^{\alpha\beta}$	$\omega_{1+}^{\#2} \tau_{1+}^{\alpha\beta}$	$f_{1+}^{\#1} \tau_{1+}^{\alpha\beta}$	$\omega_{1-}^{\#1} \tau_{1-}^{\alpha\beta}$	$\omega_{1-}^{\#2} \tau_{1-}^{\alpha\beta}$	$f_{1-}^{\#1} \tau_{1-}^{\alpha\beta}$
$k^2(2r_3+r_5) + \frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0
$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0
$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2t_2}{3}$	0	0	0
0	0	0	$\frac{1}{2}k^2(r_3+2r_5)$	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

$\omega_{2+}^{\#1} \tau_{2+}^{\alpha\beta}$	$f_{2+}^{\#1} \tau_{2+}^{\alpha\beta}$	$\omega_{2-}^{\#1} \tau_{2-}^{\alpha\beta\chi}$
$-\frac{3k^2r_3}{2}$	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

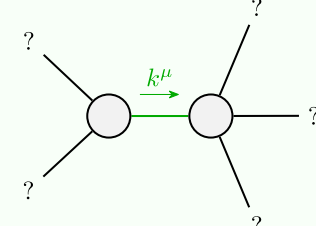
$\omega_{0+}^{\#1} \tau_{0+}^{\alpha\beta}$	$f_{0+}^{\#1} \tau_{0+}^{\alpha\beta}$	$\omega_{0-}^{\#1} \tau_{0-}^{\alpha\beta}$
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

$\sigma_{2+}^{\#1} \tau_{2+}^{\alpha\beta}$	$\sigma_{2-}^{\#1} \tau_{2-}^{\alpha\beta\chi}$
$-\frac{2}{3k^2r_3}$	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



Quadratic pole	
Pole residue:	$-\frac{1}{r_3(2r_3+r_5)(r_3+2r_5)p^2} > 0$
Polarisations:	2

Unitarity conditions

$r_2 < 0 \& r_3 < 0 \& r_5 < -\frac{r_3}{2} \& t_2 > 0 \parallel r_2 < 0 \& r_3 < 0 \& r_5 > -2r_3 \& t_2 > 0 \parallel r_2 < 0 \& r_3 > 0 \& -2r_3 < r_5 < -\frac{r_3}{2} \& t_2 > 0$