

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
$\tau_{0+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau_\alpha^\alpha$	1
$\sigma_{0+}^{\#0} == 0$	$\partial_\beta \sigma^{\alpha\beta}_\alpha == 0$	1
$\tau_{1+}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\sigma_{1+}^{\#1\alpha} == 0$	$\partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta + \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta == \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#1\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} == \partial_\beta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\alpha \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + \partial_\beta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\alpha \partial_\chi \partial^\beta \sigma^{\alpha\chi\beta}$	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^\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\delta\chi} + 2 \partial_\delta \partial^\delta \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\delta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\beta\delta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\delta\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^{\beta\delta\epsilon} + 3 \eta^{\beta\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\epsilon \sigma^{\alpha\delta}_\delta == 3 \partial_\epsilon \partial_\delta \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_\delta \partial^\alpha \sigma^{\beta\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\delta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\chi\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\beta\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\alpha\beta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \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^{\alpha\delta\epsilon} + 3 \eta^{\alpha\chi} \partial_\theta \partial^\theta \partial_\epsilon \partial^\delta \sigma^{\beta\delta}_\delta$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^{\chi\chi}_\chi + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3 \partial_\delta \partial^\delta \partial_\chi \tau^{\alpha\beta} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} == 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \tau^{\chi\delta}_\chi$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$	$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}_\chi == 2 \partial_\delta \partial^\delta \partial^\alpha \sigma^{\chi\delta}_\chi + 2 \partial_\delta \partial^\delta \partial^\alpha \sigma^{\chi\delta}_\chi + 3 (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:		36

Quadratic (free) action

$$S = \int \int \int \int \Big(\frac{1}{6} f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 4 t_2 \omega_{\beta\alpha} \partial^\beta f^{\alpha i} + 2 t_2 \partial_\alpha f_{\beta} \partial^\beta f^{\alpha i} - t_2 \partial_\alpha f_{\beta i} \partial^\beta f^{\alpha i} - t_2 \partial_i f_{\alpha\beta} \partial^\beta f^{\alpha i} + t_2 \partial_\theta f_{\alpha i} \partial^\theta f^{\alpha i} - t_2 \partial_\theta f_{i\alpha} \partial^\theta f^{\alpha i} - 4 t_2 \omega_{\alpha\theta i} (\omega^{\alpha i\theta} + \partial^\theta f^{\alpha i}) + 2 t_2 \omega_{\alpha i\theta} (\omega^{\alpha i\theta} + 2 \partial^\theta f^{\alpha i}) + 8 r_2 \partial_\beta \omega_{\alpha i\theta} \partial^\theta \omega^{\alpha\beta i} - 4 r_2 \partial_\beta \omega_{\alpha\theta i} \partial^\theta \omega^{\alpha\beta i} + 4 r_2 \partial_\beta \omega_{i\theta\alpha} \partial^\theta \omega^{\alpha\beta i} - 2 r_2 \partial_i \omega_{\alpha\beta\theta} \partial^\theta \omega^{\alpha\beta i} + 2 r_2 \partial_\beta \omega_{\alpha\beta i} \partial^\theta \omega^{\alpha\beta i} - 4 r_2 \partial_\theta \omega_{\alpha i\beta} \partial^\theta \omega^{\alpha\beta i} \Big) |t, x, y, z| dz dy dx dt$$

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

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

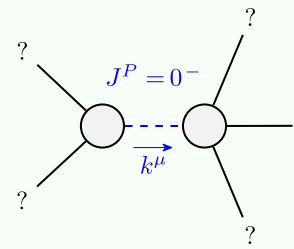
$\sigma_{2+}^{\#1} + \alpha\beta$	$\tau_{2+}^{\#1} + \alpha\beta$	$\sigma_{2+}^{\#1} + \alpha\beta\chi$
0	0	0
0	0	0
0	0	0

$\sigma_{0+}^{\#1} + \alpha\beta$	$\tau_{0+}^{\#1} + \alpha\beta$	$\tau_{0+}^{\#2} + \alpha\beta$	$\sigma_{0+}^{\#1} + \alpha\beta\chi$
0	0	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2r_2+t_2}$

$\omega_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#2} + \alpha\beta$	$\omega_{0+}^{\#1} + \alpha\beta\chi$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2r_2+t_2$

$\omega_{2+}^{\#1} + \alpha\beta$	$f_{2+}^{\#1} + \alpha\beta$	$\omega_{2+}^{\#1} + \alpha\beta\chi$
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
(see below)

Unitarity conditions

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