

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
$\tau_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^\beta_X == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	3
$\tau_{1-}^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^\beta_X == \partial_\chi \partial^\chi \partial_\beta \tau^\beta \tau^\alpha$	3
$\sigma_1^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} == 0$	3
$\sigma_1^{\#1\alpha} == 0$	$\partial_\chi \partial^\alpha \sigma^\beta_X + \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta == \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_1^{\#2\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^\beta_X + \partial_\chi \partial^\beta \tau^\alpha_X + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\chi \partial^\alpha \tau^\beta_X + \partial_\chi \partial^\beta \tau^\alpha_X + \partial_\chi \partial^\chi \tau^\beta \tau^\alpha + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi}$	3
$\sigma_2^{\#1\alpha\beta\chi} == 0$	$3 \partial_\epsilon \partial_\delta \partial^\chi \partial^\alpha \sigma^{\beta\delta\epsilon} + 3 \partial_\epsilon \partial^\epsilon \partial^\chi \partial^\alpha \sigma^{\beta\delta}_\delta + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\alpha \sigma^{\delta\epsilon}_\delta + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon} + 3 \eta^{\beta\chi} \partial_\phi \partial^\phi \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^\beta \sigma^{\alpha\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\beta \sigma^{\delta\epsilon}_\delta + 3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon} + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\epsilon \sigma^{\beta\delta}_\delta$	5
$\tau_{2+}^{\#1\alpha\beta} == 0$	$4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta}_X + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_X + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta}_X + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta}_X + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \tau^{\chi\delta} == 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta}_X + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta}_X + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta}_X + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \tau^{\chi\delta}_X$	5
Total constraints/gauge generators:		27

Quadratic (free) action

$$S = \int \int \int \int \Big(\frac{1}{6} f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 4 t_2 \omega_{\theta\alpha} \partial^\theta f^{\alpha i} + 2 t_2 \partial_\alpha f_{\theta\beta} \partial^\theta f^{\alpha i} - t_2 \partial_\alpha f_{\theta i} \partial^\theta f^{\alpha i} - t_2 \partial_i f_{\alpha\theta} \partial^\theta f^{\alpha i} + t_2 \partial_\theta f_{\alpha i} \partial^\theta f^{\alpha i} - t_2 \partial_\theta f_{i\alpha} \partial^\theta f^{\alpha i} - 4 t_2 \omega_{\alpha\theta i} (\omega^{\alpha i\theta} + \partial^\theta f^{\alpha i}) + 2 t_2 \omega_{\alpha i\theta} (\omega^{\alpha i\theta} + 2 \partial^\theta f^{\alpha i}) + 8 r_2 \partial_\beta \omega_{\alpha i\theta} \partial^\theta \omega^{\alpha\beta i} - 4 r_2 \partial_\beta \omega_{\alpha\theta i} \partial^\theta \omega^{\alpha\beta i} + 4 r_2 \partial_\beta \omega_{\alpha\theta i} \partial^\theta \omega^{\alpha\beta i} + 2 r_2 \partial_\theta \omega_{\alpha\beta i} \partial^\theta \omega^{\alpha\beta i} - 4 r_2 \partial_\theta \omega_{\alpha i\beta} \partial^\theta \omega^{\alpha\beta i} - 12 r_4 \partial_\theta \omega_{\alpha i\beta} \partial^\theta \omega^{\alpha\beta i} - 12 r_4 \partial_\theta \omega_{\alpha\beta i} \partial^\theta \omega^{\alpha\beta i} - 12 r_4 \partial_\alpha \omega^{\alpha\theta\kappa} \partial_\lambda \omega_{\kappa\theta}^\lambda + 24 r_4 \partial^\kappa \omega^{\alpha\theta} \partial_\alpha \omega_{\kappa\theta}^\lambda - 12 r_4 \partial_\alpha \omega^{\alpha\theta\kappa} \partial_\lambda \omega_{\kappa\theta}^\lambda + 24 r_4 \partial^\kappa \omega^{\alpha\theta} \partial_\alpha \omega_{\kappa\theta}^\lambda - 24 r_3 \partial_\beta \omega_{\lambda\alpha} \partial^\lambda \omega^{\alpha\beta i} \Big) [t, x, y, z] dz dy dx dt$$

$\sigma_{1+}^{\#1} + \alpha\beta$	$\frac{1}{k^2 (2r_3-r_4)}$	$-\frac{\sqrt{2}}{k^2 (1+k^2) (2r_3-r_4)}$	$-\frac{i\sqrt{2}}{k (1+k^2) (2r_3-r_4)}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
$\sigma_{1+}^{\#2} + \alpha\beta$	$-\frac{\sqrt{2}}{k^2 (1+k^2) (2r_3-r_4)}$	$\frac{k^2 (6r_3-3r_4)+2t_2}{(k+k^3)^2 (2r_3-r_4)t_2}$	$\frac{i(k^2 (6r_3-3r_4)+2t_2)}{k (1+k^2)^2 (2r_3-r_4)t_2}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
$\tau_{1+}^{\#1} + \alpha\beta$	$\frac{i\sqrt{2}}{k (1+k^2) (2r_3-r_4)}$	$-\frac{i(k^2 (6r_3-3r_4)+2t_2)}{k (1+k^2)^2 (2r_3-r_4)t_2}$	$\frac{1}{r_3} \frac{r_4}{2} \frac{t_2}{(1+k^2)^2}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
$\sigma_{1-}^{\#1} + \alpha$	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

$\omega_{1+}^{\#1} + \alpha\beta$	$k^2 (2r_3-r_4) + \frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
$\omega_{1+}^{\#2} + \alpha\beta$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
$f_{1+}^{\#1} + \alpha\beta$	$-\frac{1}{3} i \sqrt{2} k t_2$	$-\frac{1}{3} i k t_2$	$\frac{k^2 t_2}{3}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{0}{0}$
$\omega_{1-}^{\#1} + \alpha$	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

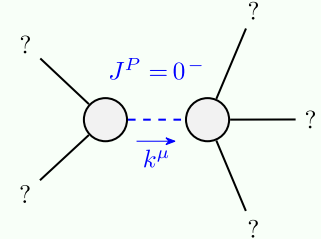
$\sigma_{0+}^{\#1} + \alpha$	$\frac{1}{-2k^2 r_3+4k^2 r_4}$	0	0	0
$\tau_{0+}^{\#1} + \alpha$	0	0	0	0
$\tau_{0+}^{\#2} + \alpha$	0	0	0	0
$\sigma_{0-}^{\#1} + \alpha$	0	0	$\frac{1}{k^2 r_2+t_2}$	0

$\omega_{0+}^{\#1} + \alpha$	$-2k^2 (r_3-2r_4)$	0	0	0
$\tau_{0+}^{\#1} + \alpha$	0	0	0	0
$\tau_{0+}^{\#2} + \alpha$	0	0	0	0
$\omega_{0-}^{\#1} + \alpha$	0	0	$k^2 r_2+t_2$	0

$\omega_{2+}^{\#1} + \alpha\beta$	$k^2 (-2r_3+r_4)$	0	0	0
$f_{2+}^{\#1} + \alpha\beta$	0	0	0	0
$\omega_{2-}^{\#1} + \alpha\beta\chi$	0	0	0	0

$\sigma_{2+}^{\#1} + \alpha\beta$	$\frac{1}{k^2 (-2r_3+r_4)}$	0	0	0
$\tau_{2+}^{\#1} + \alpha\beta$	0	0	0	0
$\sigma_{2-}^{\#1} + \alpha\beta\chi$	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

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