

Particle spectrograph

Wave operator and propagator

Source constraints		Fundamental fields	Multiplicities
SO(3) irreps			
$\sigma_0^{\#1} == 0$		$\partial_\beta \sigma^{\alpha\beta}_\alpha == 0$	1
$\tau_0^{\#1} == 0$		$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial_\beta \tau^\alpha_\alpha$	1
$\tau_0^{\#2} == 0$		$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_1^{\#2\alpha} + 2\,i\,k\,\sigma_1^{\#1\alpha} == 0$		$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} +$ $2\,(\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta - \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} +$ $\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \sigma^{\alpha\beta}_\beta) == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\sigma_1^{\#1\alpha} == \sigma_1^{\#2\alpha}$		$\partial_\chi \partial^\alpha \sigma^{\beta\chi}_\beta + \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta == 0$	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
$\tau_2^{\#1\alpha\beta} - 2\,i\,k\,\sigma_2^{\#1\alpha\beta} == 0$		$-i\,(4\,\partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau^\chi_\chi -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} +$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \tau^{\chi\delta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \sigma^{\alpha\delta\beta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \sigma^{\beta\delta\alpha} -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial^\delta \tau^\chi_\chi -$ $4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\theta \partial^\theta \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5
Total constraints/gauge generators:			20

Quadratic (free) action

$$S = \int \int \int \int (\frac{1}{6} (2 t_1 \omega^\alpha_{\alpha'} \omega^\theta_{\theta'} + 6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 4 t_1 \omega^\theta_{\alpha} \partial_\theta f^{\alpha\iota} + 4 t_1 \omega^\theta_{\iota} \partial_\theta f^{\alpha}_{\alpha'} - 2 t_1 \partial_\iota f^\theta_{\theta'} \partial_\theta f^\alpha_{\alpha'} - 6 r_1 \partial_\beta \omega^\theta_{\iota} \partial_\theta \omega^{\alpha\beta}_{\alpha'} + 6 r_1 \partial_\iota \omega^\theta_{\beta} \partial_\theta \omega^{\alpha\beta}_{\alpha'} - 2 t_1 \partial_\iota f^{\alpha\iota} \partial_\theta f^\theta_{\alpha'} + 4 t_1 \partial_\iota f^\alpha_{\alpha'} \partial_\theta f^\theta_{\iota} + 6 r_1 \partial_\alpha \omega^{\alpha\beta\iota} \partial_\theta \omega^\theta_{\beta'} + 12 r_1 \partial_\iota \omega^{\alpha\beta}_{\alpha'} \partial_\theta \omega^\theta_{\beta'} - 6 r_1 \partial_\alpha \omega^{\alpha\beta\iota} \partial_\theta \omega^\theta_{\beta'} + 3 t_1 \partial_\iota \partial_\theta f^{\alpha\iota}_{\alpha'} \partial^\beta f^{\alpha\iota}_{\alpha'} + 6 t_1 \omega_{\alpha\theta\iota} (\omega^{\alpha\iota\theta} + 2 \partial^\beta f^{\alpha\iota}_{\alpha'}) - 8 r_1 \partial_\beta \omega_{\alpha\iota\theta} \partial^\beta \omega^{\alpha\beta\iota}_{\alpha'} + 4 r_1 \partial_\beta \omega_{\alpha\theta\iota} \partial^\beta \omega^{\alpha\beta\iota}_{\alpha'} - 16 r_1 \partial_\beta \omega_{\iota\theta\alpha} \partial^\beta \omega^{\alpha\beta\iota}_{\alpha'} - 4 r_1 \partial_\iota \omega_{\alpha\theta\beta} \partial^\beta \omega^{\alpha\beta\iota}_{\alpha'} + 4 r_1 \partial_\theta \omega_{\alpha\beta\iota} \partial^\beta \omega^{\alpha\beta\iota}_{\alpha'} + 4 r_1 \partial_\theta \omega_{\alpha\iota\beta} \partial^\beta \omega^{\alpha\beta\iota}_{\alpha'})) [t, x, y, z] dz dy dx dt$$

$\sigma_{1+}^{\#1} + \alpha\beta$	$\sigma_{1+}^{\#2} + \alpha\beta$	$\tau_{1+}^{\#1} + \alpha\beta$	$\sigma_{1-}^{\#1} + \alpha$	$\sigma_{1-}^{\#2} + \alpha$	$\tau_{1-}^{\#1} + \alpha$	$\tau_{1-}^{\#2} + \alpha$
0	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{i\sqrt{2}k}{t_1+k^2}t_1$	0	0	0	0
$\sigma_{1-}^{\#2} + \alpha\beta$	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{i(2k^3r_1+kt_1)}{(1+k^2)^2t_1^2}$	0	0	0	0
$\tau_{1-}^{\#1} + \alpha\beta$	$\frac{i\sqrt{2}k}{t_1+k^2}t_1$	$\frac{-2k^4r_1+k^2t_1}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1-}^{\#1} + \alpha$	0	0	$\frac{6}{(3+4k^2)^2t_1}$	$\frac{6\sqrt{2}}{(3+4k^2)^2t_1}$	0	$\frac{12ik}{(3+4k^2)^2t_1}$
$\sigma_{1-}^{\#2} + \alpha$	0	0	0	$\frac{6\sqrt{2}}{(3+4k^2)^2t_1}$	0	$\frac{12i\sqrt{2}k}{(3+4k^2)^2t_1}$
$\tau_{1-}^{\#1} + \alpha$	0	0	0	0	0	0
$\tau_{1-}^{\#2} + \alpha$	0	0	0	$-\frac{12ik}{(3+4k^2)^2t_1}$	0	$\frac{24k^2}{(3+4k^2)^2t_1}$

$\omega_{1+}^{\#1} + \alpha\beta$	$\omega_{1+}^{\#2} + \alpha\beta$	$f_{1+}^{\#1} + \alpha\beta$	$\omega_{1-}^{\#1} + \alpha$	$\omega_{1-}^{\#2} + \alpha$	$f_{1-}^{\#1} + \alpha$	$f_{1-}^{\#2} + \alpha$
$k^2r_1 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1-}^{\#1} + \alpha$	0	0	$\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
$\omega_{1-}^{\#2} + \alpha$	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_1$
$f_{1-}^{\#1} + \alpha$	0	0	0	0	0	0
$f_{1-}^{\#2} + \alpha$	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}kt_1$	0	$\frac{2k^2t_1}{3}$

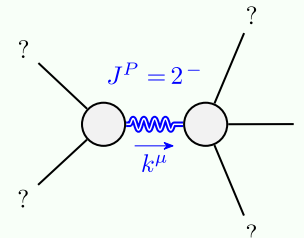
$\sigma_{2+}^{\#1} + \alpha\beta$	$\tau_{2+}^{\#1} + \alpha\beta$	$\sigma_{2-}^{\#1} + \alpha\beta\chi$
$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0
$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	0
0	0	$\frac{2}{2k^2r_1+t_1}$

$\sigma_{0+}^{\#1} +$	$\tau_{0+}^{\#1} +$	$\tau_{0+}^{\#2} +$	$\sigma_{0-}^{\#1} +$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

$\omega_{0+}^{\#1} +$	$f_{0+}^{\#1} +$	$f_{0+}^{\#2} +$	$\omega_{0-}^{\#1} +$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-t_1$

$\omega_{2+}^{\#1} + \alpha\beta$	$f_{2+}^{\#1} + \alpha\beta$	$\omega_{2-}^{\#1} + \alpha\beta\chi$
$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
0	0	$k^2r_1 + \frac{t_1}{2}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_1 < 0 \ \&\& \ t_1 > 0$