

Particle spectrograph

Wave operator and propagator

Source constraints		Fundamental fields	Multiplicities
SO(3) irreps			
$\tau_{0+}^{\#2} == 0$		$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\tau_{0+}^{\#1} == 0$		$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha_\alpha$	1
$\tau_{1-}^{\#2\alpha} + 2\,i\,k\,\sigma_{1-}^{\#1\alpha} == 0$		$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} +$ $2\,(\partial_\alpha \partial^\delta \partial_\chi \partial_\alpha \sigma^{\beta\chi}_\beta - \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} +$ $\partial_\alpha \partial^\delta \partial_\chi \partial^\chi \sigma^{\alpha\beta}_\beta) = \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\tau_{2+}^{\#1\alpha\beta} - 2\,i\,k\,\sigma_{2+}^{\#1\alpha\beta} == 0$		$-i\,(4\,\partial_\delta \partial_\chi \partial_\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\alpha \partial^\delta \partial_\beta \partial^\alpha \tau^{\chi\chi}_\chi -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\beta\chi}_\beta - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi}_\alpha - 3\,\partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $3\,\partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\alpha \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}_\epsilon -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}_\epsilon +$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha} -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^{\chi\chi}_\chi -$ $4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\theta \partial^\theta \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5
Total constraints/gauge generators:			19

Quadratic (free) action

$$S = \iiint \Big(\frac{1}{6} (2t_1\,\omega^\alpha_\alpha\,\omega^\theta_\theta + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - 4t_1\,\omega^\theta_\alpha\,\partial_\theta f^{\alpha\iota} + 4t_1\,\omega^\theta_{\iota\theta}\,\partial f^\alpha_\alpha - 2t_1\,\partial_\iota f^\theta_\theta\,\partial f^\alpha_\alpha - 24r_3\,\partial_\beta \omega^\theta_{\iota\theta}\,\partial^\iota \omega^{\alpha\beta}_\alpha - 2t_1\,\partial_\iota f^{\alpha\iota}\,\partial_\theta f^\theta_\alpha + 4t_1\,\partial_\iota f^\alpha_\alpha\,\partial_\theta f^\theta_{\iota\theta} - 24r_3\,\partial_\alpha \omega^{\alpha\beta\iota}_{\iota\theta}\,\partial_\theta \omega^\theta_{\iota\beta} + 48r_3\,\partial_\iota \omega^{\alpha\beta}_\alpha\,\partial_\theta \omega^\theta_{\iota\beta} + 4t_1\,\omega_{\iota\theta\alpha}\,\partial^\theta f^{\alpha\iota} + 4t_2\,\omega_{\iota\theta\alpha}\,\partial^\theta f^{\alpha\iota} - 4t_1\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota} + 2t_2\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota} - 4t_1\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} - t_2\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} + 2t_1\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} - t_2\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} + 2t_1\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} - t_2\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} + 2\,(t_1+t_2)\,\omega_{\alpha\iota\theta}\,(\omega^{\alpha\iota\theta} + 2\,\partial^\theta f^{\alpha\iota\iota}) + 2\,\omega_{\alpha\theta\iota}\,((t_1-2t_2)\,\omega^{\alpha\iota\theta} + 2\,(2t_1-t_2)\,\partial^\theta f^{\alpha\iota\iota}) + 8\,r_2\,\partial_\beta \omega_{\alpha\iota\theta}\,\partial^\beta \omega^{\alpha\beta\iota} - 4\,r_2\,\partial_\beta \omega_{\alpha\theta\iota}\,\partial^\beta \omega^{\alpha\beta\iota} + 4\,r_2\,\partial_\beta \omega_{\iota\theta\alpha}\,\partial^\beta \omega^{\alpha\beta\iota} - 24\,r_3\,\partial_\beta \omega_{\iota\theta\alpha}\,\partial^\beta \omega^{\alpha\beta\iota} - 2\,r_2\,\partial_\iota \omega_{\alpha\beta\theta}\,\partial^\theta \omega^{\alpha\beta\iota} + 2\,r_2\,\partial_\theta \omega_{\alpha\beta\iota}\,\partial^\theta \omega^{\alpha\beta\iota} - 4\,r_2\,\partial_\theta \omega_{\alpha\iota\beta}\,\partial^\theta \omega^{\alpha\beta\iota}) \Big) [t,\,x,\,y,\,z] dz\,dy\,dx\,dt$$

$\sigma_{1+}^{\#1\alpha\beta}$	$\sigma_{1+}^{\#2\alpha\beta}$	$\tau_{1+}^{\#1\alpha\beta}$	$\sigma_{1-}^{\#1\alpha}$	$\sigma_{1-}^{\#2\alpha}$	$\tau_{1-}^{\#1\alpha}$	$\tau_{1-}^{\#2\alpha}$
$\frac{2(t_1+t_2)}{3t_1t_2}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{i\sqrt{2}\,k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	0	0	0	0
$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$\frac{t_1+4t_2}{3(1+k^2)^2t_1t_2}$	$\frac{ik(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	0	0	0	0
$-\frac{i\sqrt{2}\,k(t_1-2t_2)}{3(1+k^2)t_1t_2}$	$-\frac{ik(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	$\frac{k^2(t_1+4t_2)}{3(1+k^2)^2t_1t_2}$	0	0	0	0
0	0	0	$\frac{6}{(3+4k^2)^2t_1}$	$\frac{6\sqrt{2}}{(3+4k^2)^2t_1}$	0	$\frac{12ik}{(3+4k^2)^2t_1}$
0	0	0	$\frac{6\sqrt{2}}{(3+4k^2)^2t_1}$	$\frac{12}{(3+4k^2)^2t_1}$	0	$\frac{12i\sqrt{2}k}{(3+4k^2)^2t_1}$
0	0	0	0	0	0	0
0	0	0	$-\frac{12ik}{(3+4k^2)^2t_1}$	$-\frac{12i\sqrt{2}k}{(3+4k^2)^2t_1}$	0	$\frac{24k^2}{(3+4k^2)^2t_1}$

$\omega_{1+}^{\#1\alpha\beta}$	$\omega_{1+}^{\#2\alpha\beta}$	$f_{1+}^{\#1\alpha\beta}$	$\omega_{1-}^{\#1\alpha}$	$\omega_{1-}^{\#2\alpha}$	$f_{1-}^{\#1\alpha}$	$f_{1-}^{\#2\alpha}$
$\frac{1}{6}(t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{i\sqrt{2}\,k(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}f\,k(t_1+t_2)$	0	0	0	0
$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}i\,k(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$	0	0	0	0
0	0	0	$\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_1$
0	0	0	0	0	0	0
0	0	0	$-\frac{1}{3}i\,kt_1$	$-\frac{1}{3}i\sqrt{2}kt_1$	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	$\frac{2}{t_1}$

$\sigma_{0+}^{\#1\alpha}$

$\tau_{0+}^{\#1\alpha}$

$\tau_{0+}^{\#2\alpha}$

$\sigma_{0+}^{\#1\alpha}$

$\frac{1}{6k^2r_3}$	0	0	0
0	0	0	0
0	0	0	0
$\frac{1}{k^2r_2+t_2}$	0	0	0

$\omega_{0+}^{\#1\alpha}$

$f_{0+}^{\#1\alpha}$

$f_{0+}^{\#2\alpha}$

$\omega_{0-}^{\#1\alpha}$

$6k^2r_3$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2r_2+t_2$

$\omega_{2+}^{\#1\alpha\beta}$

$f_{2+}^{\#1\alpha\beta}$

$\omega_{2-}^{\#1\alpha\beta\chi}$

$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
0	0	$\frac{t_1}{2}$

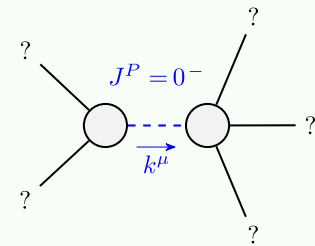
$\omega_{2+}^{\#1\alpha\beta}$

$f_{2+}^{\#1\alpha\beta}$

$\omega_{2-}^{\#1\alpha\beta\chi}$

$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
0	0	$\frac{t_1}{2}$

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

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