

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
$\tau_{1-}^{\#2\alpha} + 2\,i\,k\,\sigma_{1-}^{\#1\alpha} == 0$		$\partial_\chi \partial \theta^\alpha \tau^{\beta\chi} +$ $2\,(\partial_\beta \partial^\beta \partial_\chi \partial^\alpha \sigma^\beta \chi_\beta - \partial_\beta \partial^\beta \partial_\chi \partial_\beta \sigma^\alpha \beta \chi +$ $\partial_\beta \partial^\alpha \partial_\chi \partial^\beta \sigma^\alpha \beta)_\beta == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	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
$\tau_{1+}^{\#1\alpha\beta} + i\,k\,\sigma_{1+}^{\#2\alpha\beta} == 0$		$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} +$ $2\,\partial_\beta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\beta \partial^\beta \partial_\chi \sigma^{\alpha\beta\chi} ==$ $\partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} +$ $\partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\beta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\tau_{2+}^{\#1\alpha\beta} - 2\,i\,k\,\sigma_{2+}^{\#1\alpha\beta} == 0$		$-i\,(4\,\partial_\beta \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\beta \partial^\beta \partial^\beta \partial^\alpha \tau^{\chi}_\chi -$ $3\,\partial_\beta \partial^\beta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3\,\partial_\beta \partial^\beta \partial_\chi \partial^\alpha \tau^{\chi\beta} -$ $3\,\partial_\beta \partial^\beta \partial_\chi \partial^\beta \tau^{\alpha\chi} - 3\,\partial_\beta \partial^\beta \partial_\chi \partial^\beta \tau^{\chi\alpha} +$ $3\,\partial_\beta \partial^\beta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\beta \partial^\beta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\beta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\beta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} +$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \tau^{\chi\delta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \sigma^{\alpha\delta\beta} +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \sigma^{\beta\delta\alpha} -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\beta \partial_\chi \tau^{\chi}_\chi -$ $4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\theta \partial^\theta \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}_\delta) == 0$	5
Total constraints/gauge generators:			20

Quadratic (free) action

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

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

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

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

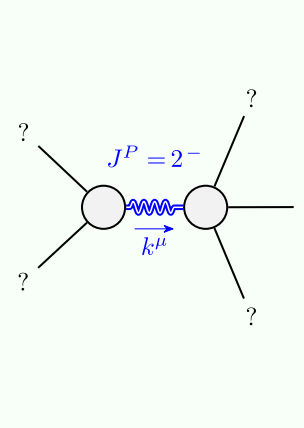
$\sigma_{0+}^{\#1} +^{\alpha}$	0	0	0	0
$\tau_{0+}^{\#1} +^{\alpha}$	0	0	0	0
$\tau_{0+}^{\#2} +^{\alpha}$	0	0	0	0
$\sigma_{0-}^{\#1} +^{\alpha}$	0	0	$-\frac{1}{t_1}$	0

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

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

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

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

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