

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
$\tau_1^{\#2\alpha} + 2\,i\,k\,\sigma_1^{\#1\alpha} == 0$			$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} +$ $2\,(\partial_\theta \partial^\theta \partial_\chi \partial^\alpha \sigma^{\beta\chi}{}_\beta - \partial_\theta \partial^\theta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} +$ $\partial_\theta \partial^\theta \partial_\chi \partial^\chi \sigma^{\alpha\beta}{}_\beta) == \partial_\chi \partial^\chi \partial_\beta \tau^\alpha{}_\beta \tau^{\alpha\beta}$		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
$\tau_{1+}^{\#1\alpha\beta} + i\,k\,\sigma_{1+}^{\#2\alpha\beta} == 0$			$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^\chi{}_\alpha + \partial_\chi \partial^\chi \tau^\alpha{}_\beta +$ $2\,\partial_\theta \partial_\chi \partial^\alpha \sigma^{\beta\chi}{}_\theta + 2\,\partial_\theta \partial^\theta \partial_\chi \sigma^{\alpha\beta\chi} ==$ $\partial_\chi \partial^\alpha \tau^\chi{}_\beta + \partial_\chi \partial^\beta \tau^\alpha{}_\chi +$ $\partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\theta \partial_\chi \partial^\beta \sigma^{\alpha\chi}{}_\theta$		3
$\tau_{2+}^{\#1\alpha\beta} - 2\,i\,k\,\sigma_{2+}^{\#1\alpha\beta} == 0$			$-i\,(4\,\partial_\theta \partial_\chi \partial^\beta \partial^\alpha \tau^\chi{}_\theta + 2\,\partial_\theta \partial^\theta \partial_\beta \partial^\alpha \tau^\chi{}_\chi -$ $3\,\partial_\theta \partial^\theta \partial_\chi \partial^\alpha \tau^{\beta\chi} - 3\,\partial_\theta \partial^\theta \partial_\chi \partial^\alpha \tau^\chi{}_\beta -$ $3\,\partial_\theta \partial^\theta \partial_\chi \partial^\beta \tau^\alpha{}_\chi - 3\,\partial_\theta \partial^\theta \partial_\chi \partial^\beta \tau^\chi{}_\alpha +$ $3\,\partial_\theta \partial^\theta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\theta \partial^\theta \partial_\chi \partial^\chi \tau^{\beta\alpha} +$ $4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}{}_\delta -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\theta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}{}_\epsilon -$ $6\,i\,k^\chi\,\partial_\epsilon \partial_\theta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}{}_\epsilon +$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\theta \partial_\chi \tau^\chi{}_\delta +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\theta \partial_\chi \sigma^{\alpha\delta\beta}{}_\beta +$ $6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\theta \partial_\chi \sigma^{\beta\delta\alpha}{}_\alpha -$ $2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\theta \partial^\delta \tau^\chi{}_\chi -$ $4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\theta \partial^\theta \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}{}_\delta) == 0$		5
Total constraints/gauge generators:					19

Quadratic (free) action

$$S = \int \int \int \int ( f^{\alpha\beta}{}_\tau \tau_{\alpha\beta} + \omega^{\alpha\beta\chi}{}_\sigma \sigma_{\alpha\beta\chi} +$$
$$\frac{1}{6} t_1 ( 2 \, \omega^{\alpha\iota}{}_\alpha \, \omega_{\iota\,\theta}{}^\theta - 4 \, \omega_{\alpha\,\theta}{}^\theta \, \partial_{\iota} f^{\alpha\iota} + 4 \, \omega_{\iota\,\theta}{}^\theta \, \partial^{\iota} f^{\alpha}{}_\alpha - 2 \, \partial_{\iota} f^{\theta}{}_\theta$$
$$\partial^{\iota} f^{\alpha}{}_\alpha - 2 \, \partial_{\iota} f^{\alpha\iota} \, \partial_{\theta} f^{\theta}{}_\alpha + 4 \, \partial^{\iota} f^{\alpha}{}_\alpha \, \partial_{\theta} f^{\theta}{}_\iota - 6 \, \partial_{\alpha} f^{\theta}{}_\iota \partial^{\theta} f^{\alpha\iota} -$$
$$3 \, \partial_{\alpha} f^{\theta}{}_\iota \partial^{\theta} f^{\alpha\iota} + 3 \, \partial_{\iota} f^{\theta}{}_\alpha \partial^{\theta} f^{\alpha\iota} + 3 \, \partial_{\theta} f^{\alpha\iota} \partial^{\theta} f^{\alpha\iota} +$$
$$3 \, \partial_{\theta} f^{\iota\alpha} \partial^{\theta} f^{\alpha\iota} + 6 \, \omega_{\alpha\theta\iota} ( \omega^{\alpha\iota\theta} + 2 \, \partial^{\theta} f^{\alpha\iota} ) ) -$$
$$4 \, r_3 ( \partial_{\beta} \omega_{\iota\,\theta} \partial^{\iota} \omega^{\alpha\beta}{}_\alpha + \partial_{\alpha} \omega^{\alpha\beta\iota}{}_\theta \partial_{\theta} \omega_{\iota\,\beta}{}^\theta -$$
$$2 \, \partial^{\iota} \omega^{\alpha\beta}{}_\alpha \, \partial_{\theta} \omega_{\iota\,\beta}{}^\theta + \partial_{\beta} \omega_{\iota\theta\alpha} \partial^{\theta} \omega^{\alpha\beta\iota} ) +$$
$$\frac{1}{3} \, r_1 ( 9 \, \partial_{\beta} \omega_{\iota\,\theta} \partial^{\iota} \omega^{\alpha\beta}{}_\alpha + 3 \, \partial_{\iota} \omega_{\beta}{}^\theta \partial^{\iota} \omega^{\alpha\beta}{}_\alpha +$$
$$3 \, \partial_{\alpha} \omega^{\alpha\beta\iota}{}_\theta \partial_{\theta} \omega_{\beta\,\iota}{}^\theta - 6 \, \partial^{\iota} \omega^{\alpha\beta}{}_\alpha \, \partial_{\theta} \omega_{\beta\,\iota}{}^\theta + 9 \, \partial_{\alpha} \omega^{\alpha\beta\iota}{}_\theta \partial_{\theta} \omega_{\beta\,\iota}{}^\theta -$$
$$18 \, \partial^{\iota} \omega^{\alpha\beta}{}_\alpha \, \partial_{\theta} \omega_{\iota\,\beta}{}^\theta - 4 \, \partial_{\beta} \omega_{\alpha\iota\theta} \partial^{\theta} \omega^{\alpha\beta\iota} +$$
$$2 \, \partial_{\beta} \omega_{\alpha\theta\iota} \partial^{\theta} \omega^{\alpha\beta\iota} + 4 \, \partial_{\beta} \omega_{\iota\theta\alpha} \partial^{\theta} \omega^{\alpha\beta\iota} -$$
$$2 \, \partial_{\iota} \omega_{\alpha\beta\theta} \partial^{\theta} \omega^{\alpha\beta\iota} + 2 \, \partial_{\theta} \omega_{\alpha\beta\iota} \partial^{\theta} \omega^{\alpha\beta\iota} +$$
$$2 \, \partial_{\theta} \omega_{\alpha\iota\beta} \partial^{\theta} \omega^{\alpha\beta\iota} ) [ t, x, y, z ] \, dz \, dy \, dx \, dt$$

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

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

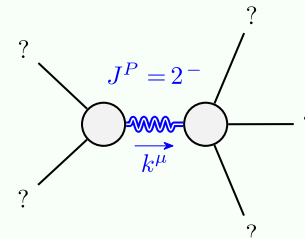
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2+}^{\#1} \dagger^{\alpha\beta\chi}$
$\frac{2}{(1+2k^2)^2}t_1$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	0
$\frac{2i\sqrt{2}k}{(1+2k^2)^2}t_1$	$\frac{4k^2}{(1+2k^2)^2}t_1$	0
0	0	$\frac{2}{2k^2r_1+t_1}$

$\omega_{0+}^{\#1} \dagger^{\alpha\beta}$	$f_{0+}^{\#1} \dagger^{\alpha\beta}$	$f_{0+}^{\#2} \dagger^{\alpha\beta}$	$\omega_{0+}^{\#1} \dagger^{\alpha}$
$6k^2(-r_1+r_3)$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

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

$\sigma_0^{\#1} \dagger^{\alpha\beta}$	$\tau_0^{\#1} \dagger^{\alpha\beta}$	$\tau_0^{\#2} \dagger^{\alpha\beta}$	$\sigma_0^{\#1} \dagger^{\alpha}$
$\frac{1}{6k^2(-r_1+r_3)}$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

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

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