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
$\tau_{0^+}^{\#1} - 2\,i\,k\,\sigma_{0^+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha{}_\alpha + 2\,\partial_\chi \partial^\chi \partial_\alpha \sigma^{\alpha\beta}{}_\alpha$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\,\sigma_{1^-}^{\#2\,\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha} + 2\,\partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	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
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\alpha\beta} == 2\,\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\tau_{2^+}^{\#1\,\alpha\beta} - 2\,i\,k\,\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	$-i\,(4\,\partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2\,\partial_\delta \partial^\beta \partial^\alpha \tau^{\chi\delta} - 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\alpha\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \tau^{\alpha\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \tau^{\beta\alpha} + 4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \sigma^{\alpha\epsilon}{}_\delta - 6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\beta\epsilon} - 6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\epsilon} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} + 6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta} + 6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha} - 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi{}_\chi - 4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\mu \partial^\mu \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}{}_\delta) == 0$	5
Total constraints/gauge generators:		16

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	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
$\sigma_{1^+}^{\#2\,\alpha\beta}\,\dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2\,t_1}$	$\frac{-2\,k^2\,r_5+t_1}{(1+k^2)^2\,t_1^2}$	$-\frac{i\,(2\,k^3\,r_5+k\,t_1)}{(1+k^2)^2\,t_1^2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1}$	$-\frac{i\,(2\,k^3\,r_5+k\,t_1)}{(1+k^2)^2\,t_1^2}$	$\frac{-2\,k^4\,r_5+k^2\,t_1}{(1+k^2)^2\,t_1^2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2\,k^2\,t_1}$	0	$\frac{2\,i\,k}{t_1+2\,k^2\,t_1}$
$\sigma_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	$\frac{\sqrt{2}}{t_1+2\,k^2\,t_1}$	$\frac{-2\,k^2\,r_5+t_1}{(1+2\,k^2\,t_1)^2}$	$-\frac{i\,\sqrt{2}\,k\,(2\,k^2\,r_5+t_1)}{(t_1+2\,k^2\,t_1)^2}$	
$\tau_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	$-\frac{2\,i\,k}{t_1+2\,k^2\,t_1}$	$\frac{i\,\sqrt{2}\,k\,(2\,k^2\,r_5+t_1)}{(t_1+2\,k^2\,t_1)^2}$	0	$\frac{-4\,k^4\,r_5+2\,k^2\,t_1}{(t_1+2\,k^2\,t_1)^2}$

Quadratic (free) action

$$S == \int\int\int (\frac{1}{2}\,t_1\,(2\,\omega^{\alpha\prime}{}_\alpha\,\omega_\prime{}^\theta{}_\theta - 4\,\omega_\alpha{}^\theta{}_\prime\,\partial_\theta f^{\alpha\prime}{}_\alpha + 4\,\omega_\prime{}^\theta{}_\theta\,\partial^\prime f^\alpha{}_\alpha - 2\,\partial_\prime f^\theta{}_\alpha\,\partial^\prime f^{\alpha\prime}{}_\theta + 4\,\partial^\prime f^\alpha{}_\alpha\,\partial_\theta f_\prime{}^\theta - 2\,\partial_\alpha f_\prime{}^\theta - \partial^\theta f^{\alpha\prime}{}_\theta\,\partial_\alpha f_\prime{}^{\alpha\prime} + \partial_\theta f_{\prime\alpha}\,\partial^\theta f^{\alpha\prime} + 2\,\omega_{\alpha\theta\prime}\,(\omega^{\alpha\theta} + 2\,\partial^\theta f^{\alpha\prime})) + \frac{1}{3}\,r_2\,(4\,\partial_\beta \omega_{\alpha\prime\theta} - 2\,\partial_\beta \omega_{\prime\theta\alpha} - \partial_\prime \omega_{\alpha\beta\theta} + \partial_\theta \omega_{\alpha\beta\prime} - 2\,\partial_\theta \omega_{\alpha\prime\beta})\,\partial^\theta \omega^{\alpha\beta\prime} + r_5\,(\partial_\prime \omega_\theta{}^\kappa{}_\kappa\,\partial^\theta \omega^{\alpha\prime}{}_\alpha - \partial_\theta \omega_\prime{}^\kappa{}_\kappa\,\partial^\theta \omega^{\alpha\prime}{}_\alpha - (\partial_\alpha \omega^{\alpha\theta} - 2\,\partial^\theta \omega^{\alpha\prime}{}_\alpha)\,(\partial_\kappa \omega_\prime{}^\kappa{}_\theta - \partial_\kappa \omega_\theta{}^\kappa{}_\prime))) [t,\, x,\, y,\, z]\,dz\,dy\,dx\,dt$$

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^+}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$-t_1$	$i\,\sqrt{2}\,k\,t_1$	0	0
$f_{0^+}^{\#1}\,\dagger$	$-i\,\sqrt{2}\,k\,t_1$	$-2\,k^2\,t_1$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	$k^2\,r_2 - t_1$
$\omega_{0^+}^{\#1}\,\dagger$	0	0	0	0

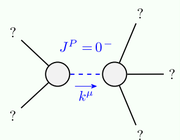
	$\omega_{2^+\,\alpha\beta}^{\#1}$	$f_{2^+\,\alpha\beta}^{\#1}$	$\omega_{2^-\,\alpha\beta\chi}^{\#1}$
$\omega_{2^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{i\,k\,t_1}{\sqrt{2}}$	$k^2\,t_1$	0
$\omega_{2^-}^{\#1\,\alpha\beta\chi}\,\dagger^{\alpha\beta\chi}$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

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

	$\omega_{1^+\,\alpha\beta}^{\#1}$	$\omega_{1^+\,\alpha\beta}^{\#2}$	$f_{1^+\,\alpha\beta}^{\#1}$	$\omega_{1^-\,\alpha}^{\#1}$	$\omega_{1^-\,\alpha}^{\#2}$	$f_{1^-\,\alpha}^{\#1}$	$f_{1^-\,\alpha}^{\#2}$
$\omega_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$k^2\,r_5 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\,\dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{i\,k\,t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	$k^2\,r_5 - \frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$i\,k\,t_1$
$\omega_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	$-i\,k\,t_1$	0	0	0

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\tau_{0^+}^{\#1}$	$\sigma_{0^+}^{\#1}$
$\sigma_{0^+}^{\#1}\,\dagger$	$-\frac{1}{(1+2\,k^2)^2\,t_1}$	$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1}$	0	0
$\tau_{0^+}^{\#1}\,\dagger$	$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1}$	$-\frac{2\,k^2}{(1+2\,k^2)^2\,t_1}$	0	0
$\tau_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\sigma_{0^+}^{\#1}\,\dagger$	0	0	0	$\frac{1}{k^2\,r_2 - t_1}$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$\frac{t_1}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_2 < 0$ && $t_1 < 0$