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	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha{}_\alpha + 2\,\partial_\alpha \partial^\chi \partial_\beta \sigma^{\alpha\beta}{}_\chi$	1
$\tau_1^{\#2\,\alpha}$ + 2 i k $\sigma_1^{\#2\,\alpha}$ == 0	$\partial_\chi \partial_\beta \sigma^{\alpha\chi} \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta} + 2\,\partial_\alpha \partial^\beta \partial_\chi \partial^\delta \sigma^{\alpha\chi}{}_{\beta\delta}$	3
$\tau_1^{\#1\,\alpha}$ == 0	$\partial_\chi \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	3
$\tau_{1^+}^{\#1\,\alpha\beta}$ + i k $\sigma_{1^+}^{\#2\,\alpha\beta}$ == 0	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2\,\partial_\alpha \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta}{}_\delta + 2\,\partial_\alpha \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi}{}_\delta == \partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2\,\partial_\alpha \partial_\chi \partial^\beta \sigma^{\alpha\chi}{}_\delta$	3
$\tau_{2^+}^{\#1\,\alpha\beta}$ - 2 i k $\sigma_{2^+}^{\#1\,\alpha\beta}$ == 0	-i (4 $\partial_\alpha \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta}$ + 2 $\partial_\alpha \partial^\beta \partial^\alpha \tau^\chi{}_\chi$ - 3 $\partial_\alpha \partial^\beta \partial_\chi \partial^\alpha \tau^{\chi\delta}$ - 3 $\partial_\alpha \partial^\delta \partial_\chi \partial^\beta \tau^{\alpha\chi}$ - 3 $\partial_\alpha \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta}$ + 3 $\partial_\alpha \partial^\beta \partial_\chi \partial^\chi \tau^{\alpha\delta}$ + 4 i k^χ $\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}{}_\delta$ - 6 i k^χ $\partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon}$ - 6 i k^χ $\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon}$ + 2 $\eta^{\alpha\beta}$ $\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta}$ + 6 i k^χ $\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta}$ + 6 i k^χ $\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha}$ - 2 $\eta^{\alpha\beta}$ $\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta}$ + 4 i k^χ $\partial_\epsilon \partial^\delta \partial_\chi \partial^\epsilon \sigma^{\alpha\beta}{}_\delta$) == 0	5
Total constraints/gauge generators:		16

Quadratic (free) action

$$\mathcal{S} == \int\int\int\int \tfrac{1}{6}\,(6 t_1\, \omega^{\alpha\prime}{}_\alpha{}^\theta{}_{\prime\theta} + 6\, f^{\alpha\beta}{}_\tau{}_{\alpha\beta} + 6\, \omega^{\alpha\beta\chi}\, \sigma_{\alpha\beta\chi} - 12 t_1\, \omega_\alpha{}^\theta{}_\theta\, \partial_\prime f^{\alpha\prime}{}_\alpha + 12 t_1\, \omega_\prime{}^\theta{}_\theta\, \partial^\prime f^\alpha{}_\alpha - 6 t_1\, \partial_\prime f^\theta{}_\theta\, \partial^\prime f^\alpha{}_\alpha - 12 r_1\, \partial_\beta \omega_\prime{}^\theta{}_\theta\, \partial^\prime \omega^{\alpha\beta}{}_\alpha + 12 r_1\, \partial_\prime \omega_\beta{}^\theta{}_\alpha\, \partial^\prime \omega^{\alpha\beta}{}_\theta + 12 t_1\, \partial^\prime f^\alpha{}_\alpha\, \partial_\theta f_\prime{}^{\alpha\prime}{}_\theta + 24 r_1\, \partial^\prime \omega^{\alpha\beta}{}_\alpha\, \partial_\theta \omega_\beta{}^\theta{}_\prime - 12 r_1\, \partial_\alpha \omega^{\alpha\beta\prime}\, \partial_\theta \omega_\prime{}^\theta{}_\beta + 24 r_1\, \partial^\prime \omega^{\alpha\beta}{}_\alpha\, \partial_\theta \omega_\prime{}^\theta{}_\beta + 4 t_1\, \omega_{\prime\theta\alpha}\, \partial^\theta f^{\alpha\prime} + 4 t_2\, \omega_{\prime\theta\alpha}\, \partial^\theta f^{\alpha\prime} - 4 t_1\, \partial_\alpha f_{\prime\theta}\, \partial^\theta f^{\alpha\prime} - 4 t_1\, \partial_\alpha f_\prime{}_\theta\, \partial^\theta f^{\alpha\prime} - t_2\, \partial_\alpha f_{\prime\theta}\, \partial^\theta f^{\alpha\prime} + 2 t_1\, \partial_\prime f_{\alpha\theta}\, \partial^\theta f^{\alpha\prime} - t_2\, \partial_\alpha f_{\alpha\theta}\, \partial^\theta f^{\alpha\prime} + 4 t_1\, \partial_\theta f_{\alpha\prime}\, \partial^\theta f^{\alpha\prime} + t_2\, \partial_\theta f_{\alpha\prime}\, \partial^\theta f^{\alpha\prime} + 2 t_1\, \partial_\theta f_{\prime\alpha}\, \partial^\theta f^{\alpha\prime} - t_2\, \partial_\theta f_{\prime\alpha}\, \partial^\theta f^{\alpha\prime} + 2\,(t_1 + t_2)\, \omega_{\alpha\prime\theta}\, (\omega^{\alpha\prime\theta} + 2\,\partial^\theta f^{\alpha\prime}) + 2\, \omega_{\alpha\theta\prime}\, ((t_1 - 2 t_2)\, \omega^{\alpha\prime\theta} + 2\,(2 t_1 - t_2)\, \partial^\theta f^{\alpha\prime}) - 8 r_1\, \partial_\beta \omega_{\alpha\prime\theta}\, \partial^\theta \omega^{\alpha\beta\prime} + 4 r_1\, \partial_\beta \omega_{\alpha\theta\prime}\, \partial^\theta \omega^{\alpha\beta\prime} - 16 r_1\, \partial_\beta \omega_{\prime\theta\alpha}\, \partial^\theta \omega^{\alpha\beta\prime} - 4 r_1\, \partial_\prime \omega_{\alpha\beta\theta}\, \partial^\theta \omega^{\alpha\beta\prime} + 4 r_1\, \partial_\theta \omega_{\alpha\beta\prime}\, \partial^\theta \omega^{\alpha\beta\prime}))[t, x, y, z]\, dz\, dy\, dx\, dt$$

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_1^{\#1\,\alpha}$	$\sigma_1^{\#2\,\alpha}$	$\tau_1^{\#1\,\alpha}$	$\tau_1^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\,\dagger$	$\frac{2(t_1+t_2)}{3 t_1 t_2}$	$\frac{i\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)t_1 t_2}$	$\frac{i\sqrt{2}\,k(t_1-2t_2)}{3(1+k^2)t_1 t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\alpha\beta}\,\dagger$	$\frac{\sqrt{2}\,(t_1-2t_2)}{3(1+k^2)t_1 t_2}$	$\frac{t_1+4t_2}{3(1+k^2)^2 t_1 t_2}$	$\frac{ik(t_1+4t_2)}{3(1+k^2)^2 t_1 t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\,\dagger$	$-\frac{i\sqrt{2}\,k(t_1-2t_2)}{3(1+k^2)t_1 t_2}$	$-\frac{ik(t_1+4t_2)}{3(1+k^2)^2 t_1 t_2}$	$\frac{k^2(t_1+4t_2)}{3(1+k^2)^2 t_1 t_2}$	0	0	0	0
$\sigma_1^{\#1\,\alpha}\,\dagger$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	0	$\frac{2ik}{t_1+2k^2 t_1}$
$\sigma_1^{\#2\,\alpha}\,\dagger$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	$\frac{2k^2 r_1+t_1}{(t_1+2k^2 t_1)^2}$	0	$\frac{i\sqrt{2}\,k(2k^2 r_1+t_1)}{(t_1+2k^2 t_1)^2}$
$\tau_1^{\#1\,\alpha}\,\dagger$	0	0	0	0	0	0	0
$\tau_1^{\#2\,\alpha}\,\dagger$	0	0	0	$-\frac{2ik}{t_1+2k^2 t_1}$	$-\frac{i\sqrt{2}\,k(2k^2 r_1+t_1)}{(t_1+2k^2 t_1)^2}$	0	$\frac{2k^2(2k^2 r_1+t_1)}{(t_1+2k^2 t_1)^2}$

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\,\dagger$	$-\frac{1}{(1+2k^2)^2 t_1}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0^+}^{\#1}\,\dagger$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$-\frac{2k^2}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\,\dagger$	0	0	0	$\frac{1}{t_2}$

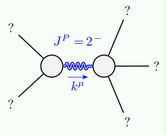
	$\sigma_{2^+}^{\#1\,\alpha\beta}$	$\tau_{2^+}^{\#1\,\alpha\beta}$	$\sigma_{2^-}^{\#1\,\alpha\beta\chi}$
$\sigma_{2^+}^{\#1\,\alpha\beta}\,\dagger$	$-\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0
$\tau_{2^+}^{\#1\,\alpha\beta}\,\dagger$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2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

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

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$-t_1$	$i\sqrt{2}\,k t_1$	0	0
$f_{0^+}^{\#1}\,\dagger$	$-i\sqrt{2}\,k t_1$	$-2k^2 t_1$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	t_2

	$\omega_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^-}^{\#1\,\alpha}$	$\omega_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{1}{6}(t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\,\dagger^{\alpha\beta}$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}ik(t_1+t_2)$	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}ik(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	$-k^2 r_1 - \frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	ikt_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	$-ikt_1$	0	0	0

Massive and massless spectra



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

(No massless particles)

Unitarity conditions

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