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

	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\,\dagger$	0	$-\frac{\sqrt{2}}{t_1+2k^2t_1}$	$-\frac{2ik}{t_1+2k^2t_1}$	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{2ik}{t_1+2k^2t_1}$
$\sigma_{1^+}^{\#2\,\alpha\beta}\,\dagger$	$-\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{-2k^2(2r_1+r_5)+t_1}{(1+k^2)^2t_1^2}$	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+2k^2t_1}$	$\frac{-2k^2(2r_1+r_5)+t_1}{(t_1+2k^2t_1)^2}$	$\frac{i\sqrt{2}\,k(2k^2(2r_1+r_5)+t_1)}{(t_1+2k^2t_1)^2}$
$\tau_{1^+}^{\#1\,\alpha\beta}\,\dagger$	$\frac{i\sqrt{2}\,k}{t_1+2k^2t_1}$	$\frac{-2k^3(2r_1+r_5)+kt_1}{(1+k^2)^2t_1^2}$	$\frac{2ik^3(2r_1+r_5)+ikt_1}{(1+k^2)^2t_1^2}$	0	$\frac{-2k^4(2r_1+r_5)+k^2t_1}{(1+k^2)^2t_1^2}$	$\frac{i(2k^3(2r_1+r_5)-kt_1)}{(1+k^2)^2t_1^2}$
$\sigma_{1^-}^{\#1\,\alpha}\,\dagger$	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$-\frac{\sqrt{2}}{t_1+2k^2t_1}$	0	$\frac{-2k^2(2r_1+r_5)+t_1}{(t_1+2k^2t_1)^2}$	$\frac{i\sqrt{2}\,k(2k^2(2r_1+r_5)-t_1)}{(t_1+2k^2t_1)^2}$
$\sigma_{1^-}^{\#2\,\alpha}\,\dagger$	0	$\frac{2ik}{t_1+2k^2t_1}$	$-\frac{2ik}{t_1+2k^2t_1}$	0	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$
$\tau_{1^-}^{\#1\,\alpha}\,\dagger$	0	$\frac{2ik}{t_1+2k^2t_1}$	$-\frac{2ik}{t_1+2k^2t_1}$	0	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$
$\tau_{1^-}^{\#2\,\alpha}\,\dagger$	0	$\frac{2ik}{t_1+2k^2t_1}$	$-\frac{2ik}{t_1+2k^2t_1}$	0	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$

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

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$-t_1$	$i\sqrt{2}\,kt_1$	0	0
$f_{0^+}^{\#1}\,\dagger$	$-i\sqrt{2}\,kt_1$	$-2k^2t_1$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	$-t_1$

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

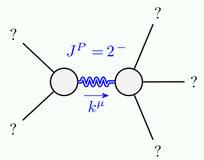
Quadratic (free) action

$$S == \int\int\int\int (f^{\alpha\beta}\,\tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} + \frac{1}{2}t_1(2\,\omega^{\alpha\iota}{}_\alpha\,\omega_\iota{}^\theta{}_\theta - 4\,\omega_\alpha{}^\theta{}_\theta\,\partial_\iota f^{\alpha\iota} + 4\,\omega_\iota{}^\theta{}_\theta\,\partial^\iota f^\alpha{}_\alpha - 2\,\partial_\theta f^{\alpha\iota}\,\partial_\theta f^\alpha{}_\iota - 2\,\partial_\theta f^\alpha{}_\alpha\,\partial_\theta f_\iota{}^\theta - 2\,\partial_\alpha f_\iota{}^\theta\,\partial_\theta f^{\alpha\iota} + 4\,\partial^\theta f^\alpha{}_\alpha\,\partial^\theta f_\iota{}^\iota + 2\,\partial_\theta f_\iota{}^\iota\,\partial^\theta f^{\alpha\iota} + 2\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} + 2\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota} + 2\,\omega_{\alpha\theta\iota}\,(\omega^{\alpha\iota\theta} + 2\,\partial^\theta f^{\alpha\iota})) - \frac{2}{3}r_1(2\,\partial_\beta\omega_{\alpha\iota\theta} - \partial_\beta\omega_{\alpha\theta\iota} - \partial_\theta\omega_{\alpha\beta\iota} + 4\,\partial_\beta\omega_{\iota\theta\alpha} + \partial_\iota\omega_{\alpha\beta\theta} - \partial_\theta\omega_{\alpha\beta\iota} - \partial_\theta\omega_{\alpha\iota\beta})\,\partial^\theta\omega^{\alpha\beta\iota} + r_5(\partial_\iota\omega_\theta{}^\kappa\,\partial^\theta\omega^{\alpha\iota}{}_\kappa - \partial_\theta\omega_\iota{}^\kappa\,\partial^\theta\omega^{\alpha\iota}{}_\kappa - (\partial_\alpha\omega^{\alpha\iota\theta} - 2\,\partial^\theta\omega^{\alpha\iota}{}_\alpha)(\partial_\kappa\omega_\iota{}^\kappa{}_\theta - \partial_\kappa\omega_\theta{}^\kappa{}_\iota)))[t,\,x,\,y,\,z]\,dt\,dx\,dy\,dz$$

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

	$\omega_{1^+}^{\#1\,\alpha}$	$f_{1^+}^{\#1\,\alpha}$	$f_{1^+}^{\#2\,\alpha}$	$\omega_{1^-}^{\#1\,\alpha}$	$\omega_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\,\dagger$	0	0	0	ikt_1	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\,\dagger$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\,\dagger$	0	0	0	$k^2(r_1+r_5)-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$-ikt_1$
$\omega_{1^-}^{\#1\,\alpha}\,\dagger$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1^-}^{\#2\,\alpha}\,\dagger$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1^-}^{\#1\,\alpha}\,\dagger$	$k^2(2r_1+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\,\dagger$	0	0	0	0	0	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

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