Particle spectrograph

Wave operator and propagator

Source constraints

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

	$\sigma^{\#1}_{1^+\,\alpha\beta}$	$\sigma^{\#2}_{1^+\,\alpha\beta}$	$\tau^{\#1}_{1^+\,\alpha\beta}$	$\sigma^{\#1}_{1^-\,\alpha}$	$\sigma^{\#2}_{1^-\,\alpha}$	$\tau^{\#1}_{1^-\,\alpha}$	$\tau^{\#2}_{1^-\,\alpha}$
$\sigma^{\#1}_{1^+}{}^\dagger{}^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2t_1}$	0	0	0	0
$\sigma^{\#2}_{1^+}{}^\dagger{}^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{-2k^2r_5+t_1}{(1+k^2)^2t_1^2}$	$-\frac{i(2k^3r_5-kt_1)}{(1+k^2)^2t_1^2}$	0	0	0	0
$\tau^{\#1}_{1^+}{}^\dagger{}^{\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1+k^2t_1}$	$\frac{i(2k^3r_5-kt_1)}{(1+k^2)^2t_1^2}$	$\frac{-2k^4r_5+k^2t_1}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma^{\#1}_{1^-}{}^\dagger{}^{\alpha}$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	0	$\frac{2ik}{t_1+2k^2t_1}$
$\sigma^{\#2}_{1^-}{}^\dagger{}^{\alpha}$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{-2k^2r_5+t_1}{(t_1+2k^2t_1)^2}$	0	$-\frac{i\sqrt{2}\,k(2k^2r_5-t_1)}{(t_1+2k^2t_1)^2}$
$\tau^{\#1}_{1^-}{}^\dagger{}^{\alpha}$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}{}^\dagger{}^{\alpha}$	0	0	0	$-\frac{2ik}{t_1+2k^2t_1}$	$\frac{i\sqrt{2}\,k(2k^2r_5-t_1)}{(t_1+2k^2t_1)^2}$	0	$\frac{-4k^4r_5+2k^2t_1}{(t_1+2k^2t_1)^2}$

Quadratic (free) action

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

	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}{}^\dagger$	$-t_1$	$i\sqrt{2}\,k\,t_1$	0	0
$f^{\#1}_{0^+}{}^\dagger$	$-i\sqrt{2}\,k\,t_1$	$-2k^2t_1$	0	0
$f^{\#2}_{0^+}{}^\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}{}^\dagger$	0	0	0	$k^2r_2-t_1$

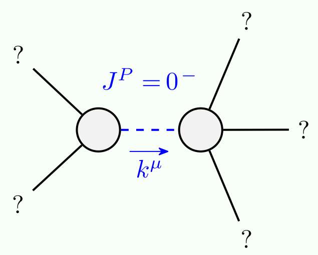
$\frac{t_1}{2}$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	0
$\frac{i\,k\,t_1}{\sqrt{2}}$	k^2t_1	0
0	0	$\frac{t_1}{2}$

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

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

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

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

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