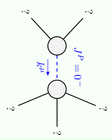
Particle spectrograph

Wave operator and propagator

Massive and massless spectra



Massive particle			
Pole residue:	$-\frac{1}{r_2} > 0$		
Polarisations:	1		
Square mass:	$-\frac{2}{r_2} > 0$		
Spin:	0		
Parity:	Odd		

(No massless particles)

Unitarity conditions

$r_2 < 0 \;\&\&\; t_2 > 0$

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
$\tau_{1^-}^{\#2\,\alpha} - i\,k\,\sigma_{1^-}^{\#1\,\alpha} == 0$	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi} + \partial_\delta\partial^\delta\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi} == \partial_\chi\partial^\chi\partial_\beta\tau^{\alpha\beta} + \partial_\delta\partial^\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi}{}_\beta + \partial_\delta\partial^\delta\partial_\chi\partial^\chi\sigma^{\alpha\beta}{}_\beta$	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
$\sigma_{1^-}^{\#1\,\alpha} + 2\,\sigma_{1^-}^{\#2\,\alpha} == 0$	$\partial_\chi\partial^\alpha\sigma^{\beta\chi}{}_\beta + \partial_\chi\partial^\chi\sigma^{\alpha\beta}{}_\beta == 3\,\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi}$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#1\,\alpha\beta} == 0$	$\partial_\chi\partial^\alpha\tau^{\beta\chi} + \partial_\chi\partial^\beta\tau^{\chi\alpha} + \partial_\chi\partial^\chi\tau^{\alpha\beta} + \partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta} + \partial_\delta\partial^\delta\partial_\chi\sigma^{\beta\chi\alpha} == \partial_\chi\partial^\alpha\tau^{\chi\beta} + \partial_\chi\partial^\beta\tau^{\alpha\chi} + \partial_\chi\partial^\chi\tau^{\beta\alpha} + \partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + \partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\chi\beta}$	3
$\sigma_{1^+}^{\#1\,\alpha\beta} == \sigma_{1^+}^{\#2\,\alpha\beta}$	$3\,\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + 2\,\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\chi\beta} + \partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\chi\beta} == 3\,\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta} + \partial_\delta\partial^\delta\partial_\chi\sigma^{\beta\chi\alpha}$	3
$\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$	$3\,\partial_\epsilon\partial_\delta\partial^\chi\partial^\alpha\sigma^{\beta\delta\epsilon} + 3\,\partial_\epsilon\partial^\epsilon\partial^\chi\partial^\alpha\sigma^{\beta\delta}{}_\delta + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\beta\sigma^{\alpha\delta\chi} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\alpha\beta\chi} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\chi\sigma^{\alpha\delta\beta} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\beta\chi\alpha} + 3\,\eta^{\beta\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial^\alpha\sigma^{\delta\epsilon}{}_\delta + 3\,\eta^{\alpha\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial_\delta\sigma^{\beta\delta\epsilon} + 3\,\eta^{\beta\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial^\epsilon\sigma^{\alpha\delta}{}_\delta == 3\,\partial_\epsilon\partial_\delta\partial^\chi\partial^\beta\sigma^{\alpha\delta\epsilon} + 3\,\partial_\epsilon\partial^\epsilon\partial^\chi\partial^\beta\sigma^{\alpha\delta}{}_\delta + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\alpha\sigma^{\beta\chi\delta} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\alpha\sigma^{\beta\delta\chi} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\chi\sigma^{\alpha\delta\beta} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\alpha\chi\beta} + 3\,\eta^{\alpha\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial^\epsilon\sigma^{\beta\delta}{}_\delta + 3\,\eta^{\beta\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial_\delta\sigma^{\alpha\delta\epsilon} + 3\,\eta^{\alpha\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial^\epsilon\sigma^{\beta\delta}{}_\delta$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	$4\,\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta} + 2\,\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^\chi{}_\chi + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\beta\alpha} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta} == 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\alpha\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^\chi{}_\chi$	5
$\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	$3\,\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + 3\,\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\sigma^{\chi\delta}{}_\chi == 2\,\partial_\delta\partial^\beta\partial^\alpha\sigma^{\chi\delta}{}_\chi + 3\,(\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\chi\beta} + \partial_\delta\partial^\delta\partial_\chi\sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:		32

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{6}{(3+k^2)^2\,t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2\,t_2}$	$\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\alpha\beta}\dagger$	$\frac{3\sqrt{2}}{(3+k^2)^2\,t_2}$	$\frac{3}{(3+k^2)^2\,t_2}$	$\frac{3\,i\,k}{(3+k^2)^2\,t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\dagger$	$-\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_2}$	$-\frac{3\,i\,k}{(3+k^2)^2\,t_2}$	$\frac{3\,k^2}{(3+k^2)^2\,t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	$\frac{6}{(3+2\,k^2)^2\,t_3}$	$-\frac{3\sqrt{2}}{(3+2\,k^2)^2\,t_3}$	0	$-\frac{6\,i\,k}{(3+2\,k^2)^2\,t_3}$
$\sigma_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$-\frac{3\sqrt{2}}{(3+2\,k^2)^2\,t_3}$	$\frac{3}{(3+2\,k^2)^2\,t_3}$	0	$\frac{3\,i\,\sqrt{2}\,k}{(3+2\,k^2)^2\,t_3}$
$\tau_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$\frac{6\,i\,k}{(3+2\,k^2)^2\,t_3}$	$-\frac{3\,i\,\sqrt{2}\,k}{(3+2\,k^2)^2\,t_3}$	0	$\frac{6\,k^2}{(3+2\,k^2)^2\,t_3}$

Quadratic (free) action

$$\mathcal{S} == \iiiint\Big(\tfrac{1}{6}\,(-4\,t_3\;\omega^{\alpha\prime}{}_\alpha\;\omega_\prime{}^\kappa{}_\kappa + 6\,f^{\alpha\beta}\;\tau_{\alpha\beta} + 6\;\omega^{\alpha\beta\chi}\;\sigma_{\alpha\beta\chi} + 8\,t_3\;\omega_\alpha{}^\kappa{}_\kappa\,\partial_\prime f^{\alpha\prime} - 8\,t_3\;\omega_\prime{}^\kappa{}_\kappa\,\partial^\prime f^\alpha{}_\alpha + 4\,t_3\,\partial_\prime f^\kappa{}_\kappa\,\partial^\prime f^\alpha{}_\alpha + 4\,t_2\;\omega_{\prime\theta\alpha}\,\partial^\theta f^{\alpha\prime} + 2\,t_2\,\partial_\alpha f_{\prime\theta}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\alpha f_{\theta\prime}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_f{}_{\alpha\theta}\,\partial^\theta f^{\alpha\prime} + t_2\,\partial_\theta f_{\alpha\prime}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\theta f_{\prime\alpha}\,\partial^\theta f^{\alpha\prime} - 4\,t_2\;\omega_{\alpha\theta\prime}\,(\omega^{\alpha\prime\theta} + \partial^\theta f^{\alpha\prime}) + 2\,t_2\;\omega_{\alpha\prime\theta}\,(\omega^{\alpha\prime\theta} + 2\,\partial^\theta f^{\alpha\prime}) + 8\,r_2\,\partial_\beta\omega_{\alpha\theta\prime}\,\partial^\theta\omega^{\alpha\beta\prime} - 4\,r_2\,\partial_\beta\omega_{\prime\theta\alpha}\,\partial^\theta\omega^{\alpha\beta\prime} - 2\,r_2\,\partial_\prime\omega_{\alpha\beta\theta}\,\partial^\theta\omega^{\alpha\beta\prime} + 2\,r_2\,\partial_\theta\omega_{\alpha\beta\prime}\,\partial^\theta\omega^{\alpha\beta\prime} - 4\,r_2\,\partial_\theta\omega_{\alpha\prime\beta}\,\partial^\theta\omega^{\alpha\beta\prime} + 4\,t_3\,\partial_\prime f^{\alpha\prime}\,\partial_\kappa f_\alpha{}^\kappa - 8\,t_3\,\partial^\prime f^\alpha{}_\alpha\,\partial_\kappa f_\prime{}^\kappa)\Big)[t,\,x,\,y,\,z]\,dz\,dy\,dx\,dt$$

	$\omega_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^-}^{\#1\,\alpha}$	$\omega_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{2\,t_2}{3}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{1}{3}\,i\,\sqrt{2}\;k\,t_2$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\dagger$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{t_2}{3}$	$\frac{i\,k\,t_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\dagger$	$-\frac{1}{3}\,i\,\sqrt{2}\;k\,t_2$	$-\frac{1}{3}\,i\,k\,t_2$	$\frac{k^2\,t_2}{3}$	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	$\frac{2\,t_3}{3}$	$-\frac{\sqrt{2}\,t_3}{3}$	0	$-\frac{2}{3}\,i\,k\,t_3$
$\omega_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$-\frac{\sqrt{2}\,t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}\,i\,\sqrt{2}\;k\,t_3$
$f_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$\frac{2\,i\,k\,t_3}{3}$	$-\frac{1}{3}\,i\,\sqrt{2}\;k\,t_3$	0	$\frac{2\,k^2\,t_3}{3}$

	$\sigma_{0^+}^{\#1}\dagger$	$\tau_{0^+}^{\#2}\dagger$	$\tau_{0^+}^{\#1}\dagger$	$\sigma_{0^+}^{\#1}\dagger$
$\sigma_{0^+}^{\#1}$	0	0	$\frac{1}{(1+2\,k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$
$\tau_{0^+}^{\#1}$	0	0	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_3}$
$\tau_{0^+}^{\#2}$	0	0	0	0
$\sigma_{0^+}^{\#1}$	0	0	0	$\frac{1}{k^2\,r_2+t_2}$

	$\omega_{0^+}^{\#1}\dagger$	$f_{0^+}^{\#2}\dagger$	$f_{0^+}^{\#1}\dagger$	$\omega_{0^+}^{\#1}\dagger$
$\omega_{0^+}^{\#1}$	0	0	$i\,\sqrt{2}\;k\,t_3$	t_3
$f_{0^+}^{\#1}$	0	0	$2\,k^2\,t_3$	$-i\,\sqrt{2}\;k\,t_3$
$f_{0^+}^{\#2}$	0	0	0	0
$\omega_{0^+}^{\#1}$	0	0	0	$k^2\,r_2+t_2$

	$\sigma_{2^+}^{\#1\,\alpha\beta}\dagger$	$\tau_{2^+}^{\#1\,\alpha\beta}\dagger$	$\sigma_{2^-}^{\#1\,\alpha\beta\chi}\dagger$
$\sigma_{2^+}^{\#1\,\alpha\beta}$	0	0	0
$\tau_{2^+}^{\#1\,\alpha\beta}$	0	0	0
$\sigma_{2^-}^{\#1\,\alpha\beta\chi}$	0	0	0

0	0	0
0	0	0
0	0	0