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
$\tau^{\#1}_{0^+}-2ik\sigma^{\#1}_{0^+}==0$	$\partial_\beta\partial_\alpha\tau^{\alpha\beta}==\partial_\beta\partial^\beta\tau^\alpha{}_\alpha+2\partial_\chi\partial^\chi\partial_\beta\sigma^{\alpha\beta}{}_\alpha$	1
$\tau^{\#2\alpha}_{1^-}+2ik\sigma^{\#2\alpha}_{1^-}==0$	$\partial_\chi\partial^\alpha\partial_\beta\tau^{\beta\chi}==\partial_\chi\partial^\chi\partial_\beta\tau^{\alpha\beta}+2\partial_\delta\partial^\delta\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi}$	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
$\tau^{\#1\alpha\beta}_{1^+}+ik\sigma^{\#2\alpha\beta}_{1^+}==0$	$\partial_\chi\partial^\alpha\tau^{\beta\chi}+\partial_\chi\partial^\beta\tau^{\chi\alpha}+\partial_\chi\partial^\chi\tau^{\alpha\beta}+2\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta}+2\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\beta\chi}==\partial_\chi\partial^\alpha\tau^{\chi\beta}+\partial_\chi\partial^\beta\tau^{\alpha\chi}+\partial_\chi\partial^\chi\tau^{\beta\alpha}+2\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta}$	3
$\tau^{\#1\alpha\beta}_{2^+}-2ik\sigma^{\#1\alpha\beta}_{2^+}==0$	$-i(4\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta}+2\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^\chi{}_\chi-3\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi}-3\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\chi\beta}-3\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\alpha\chi}-3\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha}+3\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta}+3\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\beta\alpha}+4ik^\chi\partial_\chi\partial_\epsilon\partial^\beta\partial^\alpha\sigma^{\delta\epsilon}{}_\delta-6ik^\chi\partial_\epsilon\partial_\delta\partial^\alpha\sigma^{\beta\delta\epsilon}-6ik^\chi\partial_\epsilon\partial_\delta\partial^\beta\sigma^{\alpha\delta\epsilon}+2\eta^{\alpha\beta}\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta}+6ik^\chi\partial_\epsilon\partial^\epsilon\partial_\delta\sigma^{\alpha\delta\beta}+6ik^\chi\partial_\epsilon\partial^\epsilon\partial_\delta\sigma^{\beta\delta\alpha}-2\eta^{\alpha\beta}\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^\chi{}_\chi-4i\eta^{\alpha\beta}k^\chi\partial_\phi\partial^\phi\partial_\epsilon\partial_\chi\sigma^{\delta\epsilon}{}_\delta)==0$	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
$\sigma^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{-2k^2r_5+t_1}{(1+k^2)^2t_1}$	$-\frac{i(2k^3r_5-kt_1)}{(1+k^2)^2t_1}$	0	0	0	0
$\tau^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{i\sqrt{2}k}{t_1+k^2t_1}$	$\frac{i(2k^3r_5-kt_1)}{(1+k^2)^2t_1}$	$\frac{-2k^4r_5+k^2t_1}{(1+k^2)^2t_1}$	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

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

	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}\dagger$	$-t_1$	$i\sqrt{2}kt_1$	0	0
$f^{\#1}_{0^+}\dagger$	$-i\sqrt{2}kt_1$	$-2k^2t_1$	0	0
$f^{\#2}_{0^+}\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}\dagger$	0	0	0	$k^2r_2-t_1$

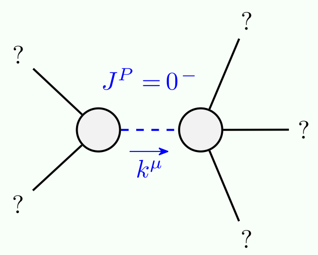
	$\omega^{\#1}_{2^+\,\alpha\beta}$	$f^{\#1}_{2^+\,\alpha\beta}$	$\omega^{\#1}_{2^-\,\alpha\beta\chi}$
$\omega^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
$\omega^{\#1}_{2^-}\dagger^{\alpha\beta\chi}$	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	$\frac{2}{t_1}$

	$\omega^{\#1}_{1^+\,\alpha\beta}$	$\omega^{\#2}_{1^+\,\alpha\beta}$	$f^{\#1}_{1^+\,\alpha\beta}$	$\omega^{\#1}_{1^-\,\alpha}$	$\omega^{\#2}_{1^-\,\alpha}$	$f^{\#1}_{1^-\,\alpha}$	$f^{\#2}_{1^-\,\alpha}$
$\omega^{\#1}_{1^+}\dagger^{\alpha\beta}$	$k^2r_5-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	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	ikt_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	$-ikt_1$	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

$r_2<0\,\&\&\,t_1<0$