Particle spectrograph

Wave operator and propagator

	$\sigma^{\#1}_{1^+}{}_{\alpha\beta}$	$\sigma^{\#2}_{1^+}{}_{\alpha\beta}$	$\tau^{\#1}_{1^+}{}_{\alpha\beta}$	$\sigma^{\#1}_{1^-}{}_{\alpha}$	$\sigma^{\#2}_{1^-}{}_{\alpha}$	$\tau^{\#1}_{1^-}{}_{\alpha}$	$\tau^{\#2}_{1^-}{}_{\alpha}$
$\sigma^{\#1}_{1^+}\dagger^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	0	0	0	0
$\sigma^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$\frac{-2k^2(2r_3+r_5)+t_1}{(1+k^2)^2 t_1^2}$	$\frac{-2ik^3(2r_3+r_5)+ikt_1}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\tau^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$\frac{i(2k^3(2r_3+r_5)-kt_1)}{(1+k^2)^2 t_1^2}$	$\frac{-2k^4(2r_3+r_5)+k^2 t_1}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\sigma^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{1}{\sqrt{2}(k^2+2k^4)(2r_3+r_5)}$	0	$-\frac{i}{k(1+2k^2)(2r_3+r_5)}$
$\sigma^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{1}{\sqrt{2}(k^2+2k^4)(2r_3+r_5)}$	$\frac{6k^2(2r_3+r_5)+t_1}{2(k+2k^3)^2(2r_3+r_5)t_1}$	0	$\frac{i(6k^2(2r_3+r_5)+t_1)}{\sqrt{2}\,k(1+2k^2)^2(2r_3+r_5)t_1}$
$\tau^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{i}{k(1+2k^2)(2r_3+r_5)}$	$-\frac{i(6k^2(2r_3+r_5)+t_1)}{\sqrt{2}\,k(1+2k^2)^2(2r_3+r_5)t_1}$	0	$\frac{6k^2(2r_3+r_5)+t_1}{(1+2k^2)^2(2r_3+r_5)t_1}$

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

	$\sigma^{\#1}_{0^+}$	$\tau^{\#1}_{0^+}$	$\tau^{\#2}_{0^+}$	$\sigma^{\#1}_{0^-}$
$\sigma^{\#1}_{0^+}\dagger$	$\frac{1}{6k^2 r_3}$	0	0	0
$\tau^{\#1}_{0^+}\dagger$	0	0	0	0
$\tau^{\#2}_{0^+}\dagger$	0	0	0	0
$\sigma^{\#1}_{0^-}\dagger$	0	0	0	$\frac{1}{k^2 r_2-t_1}$

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

	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}\dagger$	$6k^2 r_3$	0	0	0
$f^{\#1}_{0^+}\dagger$	0	0	0	0
$f^{\#2}_{0^+}\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}\dagger$	0	0	0	$k^2 r_2-t_1$

	$\omega^{\#1}_{1^+}{}_{\alpha\beta}$	$\omega^{\#2}_{1^+}{}_{\alpha\beta}$	$f^{\#1}_{1^+}{}_{\alpha\beta}$	$\omega^{\#1}_{1^-}{}_{\alpha}$	$\omega^{\#2}_{1^-}{}_{\alpha}$	$f^{\#1}_{1^-}{}_{\alpha}$	$f^{\#2}_{1^-}{}_{\alpha}$
$\omega^{\#1}_{1^+}\dagger^{\alpha\beta}$	$k^2(2r_3+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	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	$k^2(2r_3+r_5)+\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
$\omega^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}\,kt_1$
$f^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$f^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}\,kt_1$	0	$\frac{2k^2 t_1}{3}$

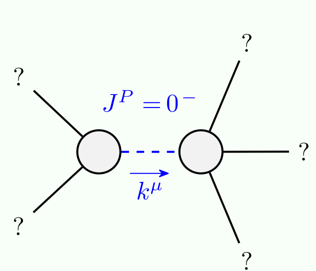
Source constraints

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

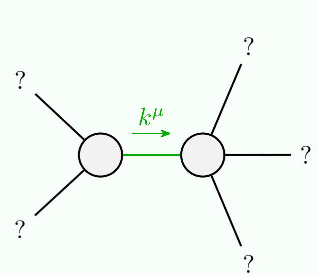
Quadratic (free) action

$$
\begin{aligned}
S==\iiiint\Big(&f^{\alpha\beta}\,\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}+\\
&\tfrac{1}{6}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}\\
&\quad\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}-6\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota}-\\
&\quad 3\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota}+3\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota}+3\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota}+\\
&\quad 3\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\iota}+6\,\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}+\\
&\quad\partial_\theta\omega_{\alpha\beta\iota}-2\,\partial_\theta\omega_{\alpha\iota\beta})\,\partial^\theta\omega^{\alpha\beta\iota}-\\
&2\,r_3\,(\partial_\beta\omega_{\iota}{}^{\theta}{}_{\theta}\,\partial^\iota\omega^{\alpha\beta}{}_{\alpha}+\partial_\iota\omega_{\beta}{}^{\theta}{}_{\theta}\,\partial^\iota\omega^{\alpha\beta}{}_{\alpha}+\partial_\alpha\omega^{\alpha\beta\iota}\,\partial_\theta\omega_{\beta}{}^{\theta}{}_{\iota}-\\
&\quad 2\,\partial^\iota\omega^{\alpha\beta}{}_{\alpha}\,\partial_\theta\omega_{\beta}{}^{\theta}{}_{\iota}+\partial_\alpha\omega^{\alpha\beta\iota}\,\partial_\theta\omega_{\iota}{}^{\theta}{}_{\beta}-\\
&\quad 2\,\partial^\iota\omega^{\alpha\beta}{}_{\alpha}\,\partial_\theta\omega_{\iota}{}^{\theta}{}_{\beta}+2\,\partial_\beta\omega_{\iota\theta\alpha}\,\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})\\
&\quad(\partial_\kappa\omega_{\iota}{}^{\kappa}{}_{\theta}-\partial_\kappa\omega_{\theta}{}^{\kappa}{}_{\iota}))\Big)[t,x,y,z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

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



Quadratic pole	
Pole residue:	$-\frac{1}{(2r_3+r_5)t_1^2}>0$
Polarisations:	2

Unitarity conditions

$r_2<0\;\&\&\;r_5<-2r_3\;\&\&\;t_1<0$