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

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

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

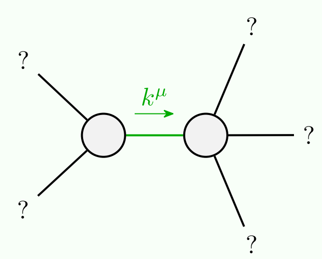
	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}\dagger$	$6k^2 r_3$	0	0	0
$f^{\#1}_{0^+}\dagger$	0	0	0	0
$f^{\#2}_{0^+}\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}\dagger$	0	0	0	$-t_1$

Quadratic (free) action

$$S == \iiiint (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}\,\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} - 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} + 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})) - 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} - 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} - 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})\,(\partial_\kappa\omega_{\iota}{}^{\kappa}{}_{\theta} - \partial_\kappa\omega_{\theta}{}^{\kappa}{}_{\iota})))[t, x, y, z]\,dz\,dy\,dx\,dt$$

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

Massive and massless spectra



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

(No massive particles)

Unitarity conditions

$r_5 < -2\,r_3\ \&\&\ t_1 < 0\ \|\ t_1 > 0$