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
$\tau^{\#2\,\alpha}_{1^-} - i k\, \sigma^{\#1\,\alpha}_{1^-} == 0$	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi} + \partial_\delta\partial^\delta\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi} == \partial_\chi\partial^\chi\partial_\beta\tau^{\alpha\beta} + \partial_\delta\partial^\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi}{}_{\beta} + \partial_\delta\partial^\delta\partial_\chi\partial^\chi\sigma^{\alpha\beta}{}_{\beta}$	3
$\tau^{\#1\,\alpha}_{1^-} == 0$	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi} == \partial_\chi\partial^\chi\partial_\beta\tau^{\beta\alpha}$	3
$\sigma^{\#1\,\alpha}_{1^-} + 2\,\sigma^{\#2\,\alpha}_{1^-} == 0$	$\partial_\chi\partial^\alpha\sigma^{\beta\chi}{}_{\beta} + \partial_\chi\partial^\chi\sigma^{\alpha\beta}{}_{\beta} == 3\,\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi}$	3
$\tau^{\#1\,\alpha\beta}_{1^+} + i k\, \sigma^{\#2\,\alpha\beta}_{1^+} == 0$	$\partial_\chi\partial^\alpha\tau^{\beta\chi} + \partial_\chi\partial^\beta\tau^{\chi\alpha} + \partial_\chi\partial^\chi\tau^{\alpha\beta} + 2\,\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + 2\,\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\beta\chi} == \partial_\chi\partial^\alpha\tau^{\chi\beta} + \partial_\chi\partial^\beta\tau^{\alpha\chi} + \partial_\chi\partial^\chi\tau^{\beta\alpha} + 2\,\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta}$	3
$\sigma^{\#1\,\alpha\beta\chi}_{2^-} == 0$	$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^\beta\sigma^{\alpha\chi\delta} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\beta\sigma^{\alpha\delta\chi} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\beta\sigma^{\chi\delta\alpha} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\chi\sigma^{\alpha\beta\delta} + 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^{\beta\delta\alpha} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\alpha\sigma^{\chi\delta\beta} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\alpha\beta\chi} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\alpha\chi\beta} + 3\,\eta^{\alpha\chi}\,\partial_\phi\partial^\phi\partial_\epsilon\partial^\beta\sigma^{\delta\epsilon}{}_{\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
$\tau^{\#1\,\alpha\beta}_{2^+} == 0$	$4\,\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta} + 2\,\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^{\chi}{}_{\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\beta\alpha} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta} == 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\chi\beta} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\alpha\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^{\chi}{}_{\chi}$	5
Total constraints/gauge generators:		24

Quadratic (free) action

$$S == \iiiint\Big(\tfrac{1}{6}\big(-4 t_3\, \omega^{\alpha\iota}{}_{\alpha}\, \omega_{\iota}{}^{\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_\iota f^{\alpha\iota} - 8 t_3\, \omega_{\iota}{}^{\kappa}{}_{\kappa}\, \partial^\iota f^{\alpha}{}_{\alpha} + 4 t_3\, \partial_\iota f^{\kappa}{}_{\kappa}\, \partial^\iota f^{\alpha}{}_{\alpha} - 6 r_3\, \partial_\beta\omega_\iota{}^\theta{}_\theta\, \partial^\iota\omega^{\alpha\beta}{}_{\alpha} - 6 r_3\, \partial_\alpha\omega^{\alpha\beta\iota}\, \partial_\theta\omega_\iota{}^\theta{}_\beta + 12 r_3\, \partial^\iota\omega^{\alpha\beta}{}_{\alpha}\, \partial_\theta\omega_\iota{}^\theta{}_\beta + 4 t_2\, \omega_{\iota\theta\alpha}\, \partial^\theta f^{\alpha\iota} + 2 t_2\, \partial_\alpha f_{\iota\theta}\, \partial^\theta f^{\alpha\iota} - t_2\, \partial_\alpha f_{\theta\iota}\, \partial^\theta f^{\alpha\iota} - t_2\, \partial_\iota f_{\alpha\theta}\, \partial^\theta f^{\alpha\iota} + t_2\, \partial_\theta f_{\alpha\iota}\, \partial^\theta f^{\alpha\iota} - t_2\, \partial_\theta f_{\iota\alpha}\, \partial^\theta f^{\alpha\iota} - 4 t_2\, \omega_{\alpha\theta\iota}\,(\omega^{\alpha\iota\theta} + \partial^\theta f^{\alpha\iota}) + 2 t_2\, \omega_{\alpha\iota\theta}\,(\omega^{\alpha\iota\theta} + 2\,\partial^\theta f^{\alpha\iota}) + 8 r_2\, \partial_\beta\omega_{\alpha\iota\theta}\, \partial^\theta\omega^{\alpha\beta\iota} + 8 r_2\, \partial_\beta\omega_{\alpha\theta\iota}\, \partial^\theta\omega^{\alpha\beta\iota} - 4 r_2\, \partial_\beta\omega_{\alpha\theta\iota}\, \partial^\theta\omega^{\alpha\beta\iota} - 4 r_2\, \partial_\beta\omega_{\iota\theta\alpha}\, \partial^\theta\omega^{\alpha\beta\iota} - 24 r_3\, \partial_\beta\omega_{\iota\theta\alpha}\, \partial^\theta\omega^{\alpha\beta\iota} - 2 r_2\, \partial_\iota\omega_{\alpha\beta\theta}\, \partial^\theta\omega^{\alpha\beta\iota} + 2 r_2\, \partial_\theta\omega_{\alpha\beta\iota}\, \partial^\theta\omega^{\alpha\beta\iota} - 4 r_2\, \partial_\theta\omega_{\alpha\iota\beta}\, \partial^\theta\omega^{\alpha\beta\iota} + 4 t_3\, \partial_\iota f^{\alpha\iota}\, \partial_\kappa f_{\alpha}{}^{\kappa} - 8 t_3\, \partial^\iota f^{\alpha}{}_{\alpha}\, \partial_\kappa f_{\iota}{}^{\kappa}\big)\Big)[t, x, y, z]\, dz\, dy\, dx\, dt$$

	$\sigma^{\#1}_{1^+\,\alpha\beta}$	$\sigma^{\#2}_{1^+\,\alpha\beta}$	$\tau^{\#1}_{1^+\,\alpha\beta}$	$\sigma^{\#1}_{1^-\,\alpha}$	$\sigma^{\#2}_{1^-\,\alpha}$	$\tau^{\#1}_{1^-\,\alpha}$	$\tau^{\#2}_{1^-\,\alpha}$
$\sigma^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{2}{3k^2 r_3}$	$-\frac{2\sqrt{2}}{3k^2 r_3+3k^4 r_3}$	$-\frac{2i\sqrt{2}}{3k r_3+3k^3 r_3}$	0	0	0	0
$\sigma^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{2\sqrt{2}}{3k^2 r_3+3k^4 r_3}$	$\frac{9k^2 r_3+4t_2}{3(k+k^3)^2 r_3 t_2}$	$\frac{i(9k^2 r_3+4t_2)}{3k(1+k^2)^2 r_3 t_2}$	0	0	0	0
$\tau^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{2i\sqrt{2}}{3k r_3+3k^3 r_3}$	$-\frac{i(9k^2 r_3+4t_2)}{3k(1+k^2)^2 r_3 t_2}$	$\frac{9k^2 r_3+4t_2}{3(1+k^2)^2 r_3 t_2}$	0	0	0	0
$\sigma^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{6}{(3+2k^2)^2 t_3}$	$-\frac{3\sqrt{2}}{(3+2k^2)^2 t_3}$	0	$-\frac{6ik}{(3+2k^2)^2 t_3}$
$\sigma^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{3\sqrt{2}}{(3+2k^2)^2 t_3}$	$\frac{3}{(3+2k^2)^2 t_3}$	0	$\frac{3i\sqrt{2}k}{(3+2k^2)^2 t_3}$
$\tau^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{6ik}{(3+2k^2)^2 t_3}$	$-\frac{3i\sqrt{2}k}{(3+2k^2)^2 t_3}$	0	$\frac{6k^2}{(3+2k^2)^2 t_3}$

	$\omega^{\#1}_{1^+\,\alpha\beta}$	$\omega^{\#2}_{1^+\,\alpha\beta}$	$f^{\#1}_{1^+\,\alpha\beta}$	$\omega^{\#1}_{1^-\,\alpha}$	$\omega^{\#2}_{1^-\,\alpha}$	$f^{\#1}_{1^-\,\alpha}$	$f^{\#2}_{1^-\,\alpha}$
$\omega^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{1}{6}(9k^2 r_3+4t_2)$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3} i\sqrt{2}\, k t_2$	0	0	0	0
$\omega^{\#2}_{1^+}\dagger^{\alpha\beta}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$f^{\#1}_{1^+}\dagger^{\alpha\beta}$	$-\frac{1}{3} i\sqrt{2}\, k t_2$	$-\frac{1}{3} i k t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3} i k t_3$
$\omega^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3} i\sqrt{2}\, k t_3$
$f^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$f^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{2ikt_3}{3}$	$-\frac{1}{3} i\sqrt{2}\, k t_3$	0	$\frac{2k^2 t_3}{3}$

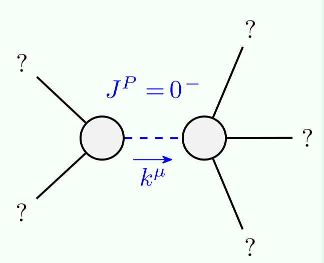
	$\omega^{\#1}_{2^+\,\alpha\beta}$	$f^{\#1}_{2^+\,\alpha\beta}$	$\omega^{\#1}_{2^-\,\alpha\beta\chi}$
$\omega^{\#1}_{2^+}\dagger^{\alpha\beta}$	$-\frac{3k^2 r_3}{2}$	0	0
$f^{\#1}_{2^+}\dagger^{\alpha\beta}$	0	0	0
$\omega^{\#1}_{2^-}\dagger^{\alpha\beta\chi}$	0	0	0

	$\sigma^{\#1}_{2^+\,\alpha\beta}$	$\tau^{\#1}_{2^+\,\alpha\beta}$	$\sigma^{\#1}_{2^-\,\alpha\beta\chi}$
$\sigma^{\#1}_{2^+}\dagger^{\alpha\beta}$	$-\frac{2}{3k^2 r_3}$	0	0
$\tau^{\#1}_{2^+}\dagger^{\alpha\beta}$	0	0	0
$\sigma^{\#1}_{2^-}\dagger^{\alpha\beta\chi}$	0	0	0

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

	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}\dagger$	t_3	$-i\sqrt{2}\, k t_3$	0	0
$f^{\#1}_{0^+}\dagger$	$i\sqrt{2}\, k t_3$	$2k^2 t_3$	0	0
$f^{\#2}_{0^+}\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}\dagger$	0	0	0	$k^2 r_2+t_2$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

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