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
$\sigma^{\#1}_{0^+} == 0$	$\partial_\beta\sigma^{\alpha\beta}{}_\alpha == 0$	1
$\tau^{\#2\,\alpha}_{1^-} + 2\,i\,k\,\sigma^{\#2\,\alpha}_{1^-} == 0$	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi} == \partial_\chi\partial^\chi\partial_\beta\tau^{\alpha\beta} + 2\,\partial_\delta\partial^\delta\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi}$	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
$\tau^{\#1\,\alpha\beta}_{1^+} + i\,k\,\sigma^{\#2\,\alpha\beta}_{1^+} == 0$	$\partial_\chi\partial^\alpha\tau^{\beta\chi} + \partial_\chi\partial^\beta\tau^{\chi\alpha} + \partial_\chi\partial^\chi\tau^{\alpha\beta} + 2\,\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + 2\,\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\beta\chi} == \partial_\chi\partial^\alpha\tau^{\chi\beta} + \partial_\chi\partial^\beta\tau^{\alpha\chi} + \partial_\chi\partial^\chi\tau^{\beta\alpha} + 2\,\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta}$	3
$\tau^{\#1\,\alpha\beta}_{2^+} - 2\,i\,k\,\sigma^{\#1\,\alpha\beta}_{2^+} == 0$	$-i\,(4\,\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta} + 2\,\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^\chi{}_\chi - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi} - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\chi\beta} - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\alpha\chi} - 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\beta\alpha} + 4\,i\,k^\chi\,\partial_\epsilon\partial_\chi\partial^\beta\partial^\alpha\sigma^{\delta\epsilon}{}_\delta - 6\,i\,k^\chi\,\partial_\epsilon\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\delta\epsilon} - 6\,i\,k^\chi\,\partial_\epsilon\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\delta\epsilon} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta} + 6\,i\,k^\chi\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\sigma^{\alpha\delta\beta} + 6\,i\,k^\chi\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\sigma^{\beta\delta\alpha} - 2\,\eta^{\alpha\beta}\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^\chi{}_\chi - 4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\phi\partial^\phi\partial_\epsilon\partial_\chi\sigma^{\delta\epsilon}{}_\delta) == 0$	5
Total constraints/gauge generators:		17

Quadratic (free) action

$$S == \iiiint(\tfrac{1}{6}(2\,t_1\,\mathcal{A}^{\alpha\iota}{}_\alpha\,\mathcal{A}_\iota{}^\theta{}_\theta + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\mathcal{A}^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - 4\,t_1\,\mathcal{A}_\alpha{}^\theta{}_\theta\,\partial_\iota f^{\alpha\iota} + 4\,t_1\,\mathcal{A}_\iota{}^\theta{}_\theta\,\partial^\iota f^\alpha{}_\alpha - 2\,t_1\,\partial_\iota f^\theta{}_\theta\,\partial^\iota f^\alpha{}_\alpha - 2\,t_1\,\partial_\iota f^{\alpha\iota}\,\partial_\theta f_\alpha{}^\theta + 4\,t_1\,\partial^\iota f^\alpha{}_\alpha\,\partial_\theta f_\iota{}^\theta - 6\,t_1\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota} - 3\,t_1\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota} + 3\,t_1\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\iota} + 3\,t_1\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota} + 3\,t_1\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\iota} + 6\,t_1\,\mathcal{A}_{\alpha\theta\iota}\,(\mathcal{A}^{\alpha\iota\theta} + 2\,\partial^\theta f^{\alpha\iota}) + 8\,r_2\,\partial_\beta\mathcal{A}_{\alpha\iota\theta}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} - 4\,r_2\,\partial_\beta\mathcal{A}_{\alpha\theta\iota}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} + 4\,r_2\,\partial_\beta\mathcal{A}_{\iota\theta\alpha}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} - 2\,r_2\,\partial_\iota\mathcal{A}_{\alpha\beta\theta}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} + 2\,r_2\,\partial_\theta\mathcal{A}_{\alpha\beta\iota}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} - 4\,r_2\,\partial_\theta\mathcal{A}_{\alpha\iota\beta}\,\partial^\theta\mathcal{A}^{\alpha\beta\iota} + 6\,r_5\,\partial_\iota\mathcal{A}_\theta{}^\kappa{}_\kappa\,\partial^\theta\mathcal{A}^{\alpha\iota}{}_\alpha - 6\,r_5\,\partial_\theta\mathcal{A}_\iota{}^\kappa{}_\kappa\,\partial^\theta\mathcal{A}^{\alpha\iota}{}_\alpha - 6\,r_5\,\partial_\alpha\mathcal{A}^{\alpha\iota\theta}\,\partial_\kappa\mathcal{A}_\iota{}^\kappa{}_\theta + 12\,r_5\,\partial^\theta\mathcal{A}^{\alpha\iota}{}_\alpha\,\partial_\kappa\mathcal{A}_\iota{}^\kappa{}_\theta + 6\,r_5\,\partial_\alpha\mathcal{A}^{\alpha\iota\theta}\,\partial_\kappa\mathcal{A}_\theta{}^\kappa{}_\iota - 12\,r_5\,\partial^\theta\mathcal{A}^{\alpha\iota}{}_\alpha\,\partial_\kappa\mathcal{A}_\theta{}^\kappa{}_\iota))[t, x, y, z]\,dz\,dy\,dx\,dt$$

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

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

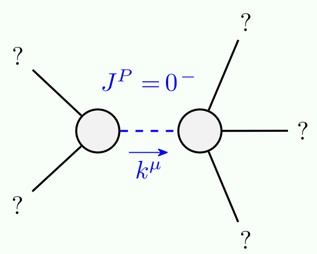
	$\mathcal{A}^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\mathcal{A}^{\#1}_{0^-}$
$\mathcal{A}^{\#1}_{0^+}\dagger$	0	0	0	0
$f^{\#1}_{0^+}\dagger$	0	0	0	0
$f^{\#2}_{0^+}\dagger$	0	0	0	0
$\mathcal{A}^{\#1}_{0^-}\dagger$	0	0	0	$k^2 r_2 - t_1$

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

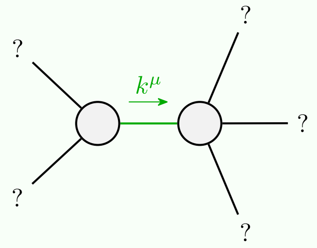
	$\mathcal{A}^{\#1}_{2^+\,\alpha\beta}$	$f^{\#1}_{2^+\,\alpha\beta}$	$\mathcal{A}^{\#1}_{2^-\,\alpha\beta\chi}$
$\mathcal{A}^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{i k t_1}{\sqrt{2}}$	0
$f^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\mathcal{A}^{\#1}_{2^-}\dagger^{\alpha\beta\chi}$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

	$\mathcal{A}^{\#1}_{1^+\,\alpha\beta}$	$\mathcal{A}^{\#2}_{1^+\,\alpha\beta}$	$f^{\#1}_{1^+\,\alpha\beta}$	$\mathcal{A}^{\#1}_{1^-\,\alpha}$	$\mathcal{A}^{\#2}_{1^-\,\alpha}$	$f^{\#1}_{1^-\,\alpha}$	$f^{\#2}_{1^-\,\alpha}$
$\mathcal{A}^{\#1}_{1^+}\dagger^{\alpha\beta}$	$k^2 r_5 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{i k t_1}{\sqrt{2}}$	0	0	0	0
$\mathcal{A}^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{i k t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\mathcal{A}^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	$k^2 r_5 + \frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{i k t_1}{3}$
$\mathcal{A}^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}\,i\,\sqrt{2}\,k t_1$
$f^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$f^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{1}{3}\,i\,k t_1$	$-\frac{1}{3}\,i\,\sqrt{2}\,k t_1$	0	$\frac{2k^2 t_1}{3}$

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:	$-\frac{1}{r_5 t_1{}^2} > 0$
Polarisations:	2

Unitarity conditions

$r_2 < 0 \;\&\&\; r_5 < 0 \;\&\&\; t_1 < 0$