Particle spectrograph

Wave operator and propagator

Source constraints

SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0^+}^{\#2} == 0$	$\partial_\beta\partial_\alpha\tau^{\alpha\beta} == 0$	1
$\tau_{0^+}^{\#1} - 2\,i\,k\,\sigma_{0^+}^{\#1} == 0$	$\partial_\beta\partial_\alpha\tau^{\alpha\beta} == \partial_\beta\partial^\beta\tau^\alpha{}_\alpha + 2\,\partial_\chi\partial^\chi\partial_\beta\sigma^{\alpha\beta}{}_\alpha$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\;\sigma_{1^-}^{\#2\,\alpha} == 0$	$\partial_\chi\partial_\beta\partial^\alpha\tau^{\beta\chi} == \partial_\chi\partial^\chi\partial_\beta\tau^{\alpha\beta} + 2\,\partial_\delta\partial^\delta\partial_\chi\partial_\beta\sigma^{\alpha\beta\chi}$	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
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\;\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	$\partial_\chi\partial^\alpha\tau^{\beta\chi} + \partial_\chi\partial^\beta\tau^{\chi\alpha} + \partial_\chi\partial^\chi\tau^{\alpha\beta} +$ $2\,\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + 2\,\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\beta\chi} ==$ $\partial_\chi\partial^\alpha\tau^{\chi\beta} + \partial_\chi\partial^\beta\tau^{\alpha\chi} +$ $\partial_\chi\partial^\chi\tau^{\beta\alpha} + 2\,\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta}$	3
$\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$	$3\,\partial_\epsilon\partial_\delta\partial^\chi\partial^\alpha\sigma^{\beta\delta\epsilon} + 3\,\partial_\epsilon\partial^\epsilon\partial^\chi\partial^\alpha\sigma^{\beta\delta}{}_\delta +$ $2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\beta\sigma^{\alpha\chi\delta} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\beta\sigma^{\alpha\delta\chi} +$ $2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\beta\sigma^{\chi\delta\alpha} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\chi\sigma^{\alpha\beta\delta} +$ $2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\chi\sigma^{\alpha\delta\beta} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\beta\chi\alpha} +$ $3\;\eta^{\beta\chi}\;\partial_\phi\partial^\phi\partial_\epsilon\partial^\alpha\sigma^{\delta\epsilon}{}_\delta +$ $3\;\eta^{\alpha\chi}\;\partial_\phi\partial^\phi\partial_\epsilon\partial_\delta\sigma^{\beta\delta\epsilon} +$ $3\;\eta^{\beta\chi}\;\partial_\phi\partial^\phi\partial_\epsilon\partial^\epsilon\sigma^{\alpha\delta}{}_\delta ==$ $3\,\partial_\epsilon\partial_\delta\partial^\chi\partial^\beta\sigma^{\alpha\delta\epsilon} + 3\,\partial_\epsilon\partial^\epsilon\partial^\chi\partial^\beta\sigma^{\alpha\delta}{}_\delta +$ $2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\alpha\sigma^{\beta\chi\delta} + 4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\alpha\sigma^{\beta\delta\chi} +$ $2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\alpha\sigma^{\chi\delta\beta} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\chi\sigma^{\beta\delta\alpha} +$ $4\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\alpha\beta\chi} + 2\,\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\sigma^{\alpha\chi\beta} +$ $3\;\eta^{\alpha\chi}\;\partial_\phi\partial^\phi\partial_\epsilon\partial^\beta\sigma^{\delta\epsilon}{}_\delta +$ $3\;\eta^{\beta\chi}\;\partial_\phi\partial^\phi\partial_\epsilon\partial_\delta\sigma^{\alpha\delta\epsilon} +$ $3\;\eta^{\alpha\chi}\;\partial_\phi\partial^\phi\partial_\epsilon\partial^\epsilon\sigma^{\beta\delta}{}_\delta$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	$4\,\partial_\delta\partial_\chi\partial^\beta\partial^\alpha\tau^{\chi\delta} + 2\,\partial_\delta\partial^\delta\partial^\beta\partial^\alpha\tau^\chi{}_\chi +$ $3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\alpha\beta} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\chi\tau^{\beta\alpha} +$ $2\;\eta^{\alpha\beta}\;\partial_\epsilon\partial^\epsilon\partial_\delta\partial_\chi\tau^{\chi\delta} ==$ $3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\beta\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\alpha\tau^{\chi\beta} +$ $3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\alpha\chi} + 3\,\partial_\delta\partial^\delta\partial_\chi\partial^\beta\tau^{\chi\alpha} +$ $2\;\eta^{\alpha\beta}\;\partial_\epsilon\partial^\epsilon\partial_\delta\partial^\delta\tau^\chi{}_\chi$	5
$\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	$3\,\partial_\delta\partial_\chi\partial^\alpha\sigma^{\beta\chi\delta} + 3\,\partial_\delta\partial_\chi\partial^\beta\sigma^{\alpha\chi\delta} +$ $2\;\eta^{\alpha\beta}\;\partial_\epsilon\partial^\epsilon\partial_\delta\sigma^{\chi\delta}{}_\chi == 2\,\partial_\delta\partial^\beta\partial^\alpha\sigma^{\chi\delta}{}_\chi +$ $3\,(\partial_\delta\partial^\delta\partial_\chi\sigma^{\alpha\chi\beta} + \partial_\delta\partial^\delta\partial_\chi\sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:		26

Quadratic (free) action

$$
\begin{aligned}
\mathcal{S} ==\; & \iiiint\Big(\tfrac{1}{6}\,(-4\,t_3\,\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} + 8\,t_3\,\mathcal{A}_\alpha{}^\theta{}_\theta\,\partial_\iota f^{\alpha\iota} - 8\,t_3 \\
& \mathcal{A}_\iota{}^\theta{}_\theta\,\partial^\iota f^\alpha{}_\alpha + 4\,t_3\,\partial_\iota f^\theta{}_\theta\,\partial^\iota f^\alpha{}_\alpha + 4\,t_3\,\partial_\iota f^{\alpha\iota}\,\partial_\theta f_\alpha{}^\theta - \\
& 8\,t_3\,\partial^\iota f^\alpha{}_\alpha\,\partial_\theta f_\iota{}^\theta + 4\,t_2\,\mathcal{A}_{\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\,\mathcal{A}_{\alpha\theta\iota}\,(\mathcal{A}^{\alpha\iota\theta} + \partial^\theta f^{\alpha\iota}) + \\
& 2\,t_2\,\mathcal{A}_{\alpha\iota\theta}\,(\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)\Big)[t, x, y, z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

	$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_\alpha$	$\sigma_{1^-}^{\#2}{}_\alpha$	$\tau_{1^-}^{\#1}{}_\alpha$	$\tau_{1^-}^{\#2}{}_\alpha$
$\sigma_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{1}{k^2 r_5}$	$-\frac{\sqrt{2}}{k^2 r_5+k^4 r_5}$	$-\frac{i\sqrt{2}}{k r_5+k^3 r_5}$	0	0	0	0
$\sigma_{1^+}^{\#2}\dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{k^2 r_5+k^4 r_5}$	$\frac{3k^2 r_5+2t_2}{(k+k^3)^2 r_5 t_2}$	$\frac{i(3k^2 r_5+2t_2)}{k(1+k^2)^2 r_5 t_2}$	0	0	0	0
$\tau_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{i\sqrt{2}}{k r_5+k^3 r_5}$	$-\frac{i(3k^2 r_5+2t_2)}{k(1+k^2)^2 r_5 t_2}$	$\frac{3k^2 r_5+2t_2}{(1+k^2)^2 r_5 t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1}\dagger^{\alpha}$	0	0	0	$\frac{1}{k^2 r_5}$	$\frac{\sqrt{2}}{k^2 r_5+2k^4 r_5}$	0	$\frac{2i}{k r_5+2k^3 r_5}$
$\sigma_{1^-}^{\#2}\dagger^{\alpha}$	0	0	0	$\frac{\sqrt{2}}{k^2 r_5+2k^4 r_5}$	$\frac{3k^2 r_5+2t_3}{(k+2k^3)^2 r_5 t_3}$	0	$\frac{i\sqrt{2}\,(3k^2 r_5+2t_3)}{k(1+2k^2)^2 r_5 t_3}$
$\tau_{1^-}^{\#1}\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2}\dagger^{\alpha}$	0	0	0	$-\frac{2i}{k r_5+2k^3 r_5}$	$-\frac{i\sqrt{2}\,(3k^2 r_5+2t_3)}{k(1+2k^2)^2 r_5 t_3}$	0	$\frac{6k^2 r_5+4t_3}{(1+2k^2)^2 r_5 t_3}$

	$\mathcal{A}_{1^+}^{\#1}{}_{\alpha\beta}$	$\mathcal{A}_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\mathcal{A}_{1^-}^{\#1}{}_\alpha$	$\mathcal{A}_{1^-}^{\#2}{}_\alpha$	$f_{1^-}^{\#1}{}_\alpha$	$f_{1^-}^{\#2}{}_\alpha$
$\mathcal{A}_{1^+}^{\#1}\dagger^{\alpha\beta}$	$k^2 r_5+\frac{2t_2}{3}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{1}{3}\,i\,\sqrt{2}\,k t_2$	0	0	0	0
$\mathcal{A}_{1^+}^{\#2}\dagger^{\alpha\beta}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	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
$\mathcal{A}_{1^-}^{\#1}\dagger^{\alpha}$	0	0	0	$k^2 r_5+\frac{2t_3}{3}$	$-\frac{\sqrt{2}\,t_3}{3}$	0	$-\frac{2}{3}\,i\,k t_3$
$\mathcal{A}_{1^-}^{\#2}\dagger^{\alpha}$	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
$f_{1^-}^{\#2}\dagger^{\alpha}$	0	0	0	$\frac{2 i k t_3}{3}$	$-\frac{1}{3}\,i\,\sqrt{2}\,k t_3$	0	$\frac{2k^2 t_3}{3}$

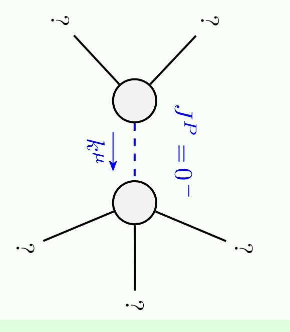
	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\dagger$	$\frac{1}{(1+2k^2)^2 t_3}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0^+}^{\#1}\dagger$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_3}$	$\frac{2k^2}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0^+}^{\#2}\dagger$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

	$\mathcal{A}_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\mathcal{A}_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\mathcal{A}_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$f_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$\mathcal{A}_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	0

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

	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$\tau_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$\sigma_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	0

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

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