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

Quadratic (free) action
$S == \int\int\int\int (\frac{1}{6}(-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 - 15\,r_3\,\partial_\beta \omega_\iota{}^\theta{}_\theta\,\partial^\iota \omega^{\alpha\beta}{}_\alpha + 9\,r_3\,\partial_\iota \omega_\beta{}^\theta{}_\theta\,\partial^\iota \omega^{\alpha\beta}{}_\alpha + 9\,r_3\,\partial_\alpha \omega^{\alpha\beta\iota}\,\partial_\theta \omega_\beta{}^\theta{}_\iota - 18\,r_3\,\partial^\iota \omega^{\alpha\beta}{}_\alpha\,\partial_\theta \omega_\beta{}^\theta{}_\iota - 15\,r_3\,\partial_\alpha \omega^{\alpha\beta\iota}\,\partial_\theta \omega_\iota{}^\theta{}_\beta + 30\,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} - 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))[t, x, y, z]\,dz\,dy\,dx\,dt$

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{6}{(3+k^2)^2 t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3i\sqrt{2}\,k}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\alpha\beta}\dagger$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3}{(3+k^2)^2 t_2}$	$\frac{3ik}{(3+k^2)^2 t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\dagger$	$-\frac{3i\sqrt{2}\,k}{(3+k^2)^2 t_2}$	$-\frac{3ik}{(3+k^2)^2 t_2}$	$\frac{3k^2}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	$-\frac{2}{3k^2 r_3}$	$-\frac{2\sqrt{2}}{3k^2 r_3 + 6k^4 r_3}$	0	$-\frac{4i}{3kr_3 + 6k^3 r_3}$
$\sigma_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$-\frac{2\sqrt{2}}{3k^2 r_3 + 6k^4 r_3}$	$\frac{9k^2 r_3 \cdot 4t_3}{3(k+2k^3)^2 r_3 t_3}$	0	$\frac{i\sqrt{2}\,(9k^2 r_3 \cdot 4t_3)}{3k(1+2k^2)^2 r_3 t_3}$
$\tau_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$\frac{4i}{3kr_3 + 6k^3 r_3}$	$-\frac{i\sqrt{2}\,(9k^2 r_3 \cdot 4t_3)}{3k(1+2k^2)^2 r_3 t_3}$	0	$\frac{2(9k^2 r_3 \cdot 4t_3)}{3(1+2k^2)^2 r_3 t_3}$

	$\omega_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^-}^{\#1\,\alpha}$	$\omega_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{2t_2}{3}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{1}{3}i\sqrt{2}\;kt_2$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\dagger$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\dagger$	$-\frac{1}{3}i\sqrt{2}\;kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	$\frac{1}{6}(-9k^2 r_3 + 4t_3)$	$-\frac{\sqrt{2}\,t_3}{3}$	0	$-\frac{2}{3}ikt_3$
$\omega_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$-\frac{\sqrt{2}\,t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}\;kt_3$
$f_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$\frac{2ikt_3}{3}$	$-\frac{1}{3}i\sqrt{2}\;kt_3$	0	$\frac{2k^2 t_3}{3}$

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

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

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$f_{0^+}^{\#1}$	$\omega_{0^+}^{\#1}$
$\omega_{0^+}^{\#1}\dagger$	0	0	$\sqrt{2}\,kt_3$	t_3
$f_{0^+}^{\#2}\dagger$	0	0	$2k^2 t_3$	$-i\sqrt{2}\,kt_3$
$f_{0^+}^{\#1}\dagger$	0	0	0	0
$\omega_{0^+}^{\#1}\dagger$	$k^2 r_3 + t_3$	0	0	0

	$\sigma_{2^+}^{\#1\,\alpha\beta}$	$\tau_{2^+}^{\#1\,\alpha\beta}$	$\sigma_{2^+}^{\#2\,\alpha\beta}$
$\sigma_{2^+}^{\#1\,\alpha\beta}\dagger$	0	0	$-\frac{2}{3k^2 r_3}$
$\tau_{2^+}^{\#1\,\alpha\beta}\dagger$	0	0	0
$\sigma_{2^+}^{\#2\,\alpha\beta}\dagger$	0	0	0

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

Massive and massless spectra

Massive particle					
Pole residue:	$-\frac{1}{r_2} > 0$				
Square mass:	$-\frac{t_2}{r_2} > 0$				
Polarisations:	1	3	5	3	1
Spin:	0	1	2	1	0
Parity:	Odd				

(No massless particles)

Unitarity conditions

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