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
$\tau^{\#2}_{1^-}{}^\alpha + 2\, i\, k\, \sigma^{\#2}_{1^-}{}^\alpha == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta} + 2\, \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	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
$\sigma^{\#2}_{1^+}{}^\dagger{}^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$\frac{1}{(1+k^2)^2 t_1}$	$\frac{i\,k}{(1+k^2)^2 t_1}$	0	0	0	0
$\tau^{\#1}_{1^+}{}^\dagger{}^{\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$-\frac{i\,k}{(1+k^2)^2 t_1}$	$\frac{k^2}{(1+k^2)^2 t_1}$	0	0	0	0
$\sigma^{\#1}_{1^-}{}^\dagger{}^\alpha$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	0	$\frac{2\,i\,k}{t_1+2k^2 t_1}$
$\sigma^{\#2}_{1^-}{}^\dagger{}^\alpha$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	$\frac{1}{(1+2k^2)^2 t_1}$	0	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$
$\tau^{\#1}_{1^-}{}^\dagger{}^\alpha$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}{}^\dagger{}^\alpha$	0	0	0	$-\frac{2\,i\,k}{t_1+2k^2 t_1}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0	$\frac{2k^2}{(1+2k^2)^2 t_1}$

Quadratic (free) action

$$S == \iiiint (f^{\alpha\beta}\ \tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\ \sigma_{\alpha\beta\chi} + \frac{1}{2} t_1 (2\ \omega^{\alpha\iota}{}_\alpha\ \omega_\iota{}^\theta{}_\theta - 4\ \omega_\alpha{}^\theta{}_\theta\, \partial_\iota f^{\alpha\iota} + 4\ \omega_\iota{}^\theta{}_\theta\, \partial^\iota f^\alpha{}_\alpha - 2\, \partial_\iota f^\theta{}_\theta\, \partial^\iota f^\alpha{}_\alpha - 2\, \partial_\iota f^{\alpha\iota}\, \partial_\theta f_\alpha{}^\theta + 4\, \partial^\iota f^\alpha{}_\alpha\, \partial_\theta f_\iota{}^\theta - 2\, \partial_\alpha f_{\iota\theta}\, \partial^\theta f^{\alpha\iota} - \partial_\alpha f_{\theta\iota}\, \partial^\theta f^{\alpha\iota} + \partial_\iota f_{\alpha\theta}\, \partial^\theta f^{\alpha\iota} + \partial_\theta f_{\alpha\iota}\, \partial^\theta f^{\alpha\iota} + \partial_\theta f_{\iota\alpha}\, \partial^\theta f^{\alpha\iota} + 2\ \omega_{\alpha\theta\iota}\ (\omega^{\alpha\iota\theta} + 2\, \partial^\theta f^{\alpha\iota})) + \frac{1}{3} r_2 (4\, \partial_\beta \omega_{\alpha\iota\theta} - 2\, \partial_\beta \omega_{\alpha\theta\iota} + 2\, \partial_\beta \omega_{\iota\theta\alpha} - \partial_\iota \omega_{\alpha\beta\theta} + \partial_\theta \omega_{\alpha\beta\iota} - 2\, \partial_\theta \omega_{\alpha\iota\beta})\, \partial^\theta \omega^{\alpha\beta\iota})[t, x, y, z]\, dz\, dy\, dx\, dt$$

	$\sigma^{\#1}_{0^+}$	$\tau^{\#1}_{0^+}$	$\tau^{\#2}_{0^+}$	$\sigma^{\#1}_{0^-}$
$\sigma^{\#1}_{0^+}{}^\dagger$	$-\frac{1}{(1+2k^2)^2 t_1}$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0	0
$\tau^{\#1}_{0^+}{}^\dagger$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$-\frac{2k^2}{(1+2k^2)^2 t_1}$	0	0
$\tau^{\#2}_{0^+}{}^\dagger$	0	0	0	0
$\sigma^{\#1}_{0^-}{}^\dagger$	0	0	0	$\frac{1}{k^2 r_2 - t_1}$

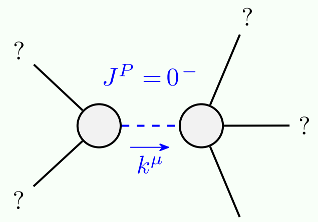
	$\sigma^{\#1}_{2^+}{}_{\alpha\beta}$	$\tau^{\#1}_{2^+}{}_{\alpha\beta}$	$\sigma^{\#1}_{2^-}{}_{\alpha\beta\chi}$
$\sigma^{\#1}_{2^+}{}^\dagger{}^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2\,i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0
$\tau^{\#1}_{2^+}{}^\dagger{}^{\alpha\beta}$	$\frac{2\,i\sqrt{2}\,k}{(1+2k^2)^2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

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

$\frac{t_1}{2}$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	0
$\frac{i\,k\,t_1}{\sqrt{2}}$	$k^2\, t_1$	0
0	0	$\frac{t_1}{2}$

	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}{}^\dagger$	$-t_1$	$i\sqrt{2}\,k\,t_1$	0	0
$f^{\#1}_{0^+}{}^\dagger$	$-i\sqrt{2}\,k\,t_1$	$-2k^2\, t_1$	0	0
$f^{\#2}_{0^+}{}^\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}{}^\dagger$	0	0	0	$k^2 r_2 - t_1$

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

(No massless particles)

Unitarity conditions

$r_2 < 0\ \&\&\ t_1 < 0$