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
$\tau_{0^+}^{\#1} - 2\,i\,k\,\sigma_{0^+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\rho \tau^{\alpha}{}_{\rho} + 2\,\partial_\chi \partial^\chi \partial_\beta \sigma^{\alpha\beta}$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\,\sigma_{1^-}^{\#2\,\alpha} == 0$	$\partial_\chi \partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\chi \partial^\chi \tau^{\beta}{}_{\alpha} + 2\,\partial_\delta \partial^\delta \partial_\beta \sigma^{\alpha\beta} - 2\,\partial_\chi \partial^\chi \partial_\beta \sigma^{\alpha\beta}$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	$\partial_\chi \partial_\beta \tau^{\alpha\beta} == \partial_\chi \partial^\chi \sigma_\beta{}^{\alpha}$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2\,\partial_\delta \partial^\alpha \partial^\beta \sigma^{\chi\delta} + 2\,\partial_\delta \partial^\delta \partial^\alpha \sigma^{\beta\chi} + 2\,\partial_\delta \partial^\delta \partial^\beta \sigma^{\alpha\chi} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\delta \partial^\delta \partial^\chi \sigma^{\alpha\beta}{}_{\chi}$	3
$\tau_{2^+}^{\#1\,\alpha\beta} - 2\,i\,k\,\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	$-i\,(4\,\partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2\,\partial_\delta \partial^\delta \partial^\beta \sigma^{\alpha\chi}{}_{\chi} - 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} - 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha} - 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\chi\alpha\beta} + 3\,\partial_\delta \partial^\delta \partial_\chi \sigma^{\chi\beta\alpha} + 4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \sigma^{\alpha\delta}{}_{\delta} - 6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\beta\delta\epsilon} - 6\,i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} + 6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\delta\beta} + 6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha} - 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^{\chi}{}_{\chi} - 4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}{}_{\delta}) == 0$	5
Total constraints/gauge generators:		16

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\,\dagger$	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
$\sigma_{1^+}^{\#2\,\alpha\beta}\,\dagger$	$-\frac{\sqrt{2}}{t_1+k^2\,t_1}$	$\frac{1}{(1+k^2)^2\,t_1}$	$\frac{i\,k}{(1+k^2)^2\,t_1}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\,\dagger$	$\frac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1}$	$-\frac{i\,k}{(1+k^2)^2\,t_1}$	$-\frac{k^2}{(1+k^2)^2\,t_1}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\,\dagger$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2\,k^2\,t_1}$	0	$\frac{2\,i\,k}{t_1+2\,k^2\,t_1}$
$\sigma_{1^-}^{\#2\,\alpha}\,\dagger$	0	0	0	$\frac{\sqrt{2}}{t_1+2\,k^2\,t_1}$	$\frac{1}{(1+2\,k^2)^2\,t_1}$	0	$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1}$
$\tau_{1^-}^{\#1\,\alpha}\,\dagger$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\,\dagger$	0	0	0	$-\frac{2\,i\,k}{t_1+2\,k^2\,t_1}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1}$	0	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_1}$

Quadratic (free) action

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

	$\omega_1^{\#1\,\alpha\beta}$	$\omega_1^{\#2\,\alpha\beta}$	$f_1^{\#1\,\alpha\beta}$	$\omega_1^{\#1\,\alpha}$	$\omega_1^{\#2\,\alpha}$	$f_1^{\#1\,\alpha}$	$f_1^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\,\dagger$	$-t_1$	$-\frac{t_1}{\sqrt{2}}$	$\frac{i\,k\,t_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\,\dagger$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\,\dagger$	$\frac{i\,k\,t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\,\dagger$	0	0	0	$-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	$i\,k\,t_1$	0
$\omega_{1^-}^{\#2\,\alpha}\,\dagger$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1^-}^{\#1\,\alpha}\,\dagger$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\,\dagger$	0	0	0	$-i\,k\,t_1$	0	0	0

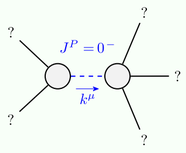
	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\,\dagger$	$-\frac{1}{(1+2\,k^2)^2\,t_1}$	$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1}$	0	0
$\tau_{0^+}^{\#1}\,\dagger$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_1}$	$-\frac{2\,k^2}{(1+2\,k^2)^2\,t_1}$	0	0
$\tau_{0^+}^{\#2}\,\dagger$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

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

	$\omega_{2^+}^{\#1\,\alpha\beta}$	$f_{2^+}^{\#1\,\alpha\beta}$	$\omega_{2^-}^{\#1\,\alpha\beta\chi}$
$\omega_{2^+}^{\#1\,\alpha\beta}\,\dagger$	$\frac{t_1}{2}$	$\frac{i\,k\,t_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1\,\alpha\beta}\,\dagger$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	$k^2\,t_1$	0
$\omega_{2^-}^{\#1\,\alpha\beta\chi}\,\dagger$	0	0	$\frac{t_1}{2}$

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$-t_1$	$i\,\sqrt{2}\,k\,t_1$	0	0
$f_{0^+}^{\#1}\,\dagger$	$-i\,\sqrt{2}\,k\,t_1$	$-2\,k^2\,t_1$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	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

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