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

Quadratic (free) action

$$S == \int\int\int (f^{\alpha\beta}\ \tau_{\alpha\beta} + \mathcal{F}^{\alpha\beta\chi}\ \sigma_{\alpha\beta\chi} + \frac{1}{2} t_1 (2\,\mathcal{F}^{\alpha\prime}{}_\alpha{}^\theta\ \mathcal{F}_\theta{}^{\prime}{}_\alpha - 4\,\mathcal{F}_\alpha{}^\theta{}_{,\theta}\ \partial_\prime f^{\alpha\prime}{}_\alpha + 4\,\mathcal{F}_{\prime,\theta}{}^\theta\ \partial_\prime f^\alpha{}_\alpha - 2\,\partial_\prime f^\theta{}_\theta\ \partial^\prime f^\alpha{}_\alpha - 2\,\partial_\prime f^{\alpha\prime}{}_\theta\ \partial_\theta f_\alpha{}^\theta + 4\,\partial^\prime f^\alpha{}_\theta\ \partial_\theta f_\prime{}^\theta - 2\,\partial_\alpha f_{\prime\theta}\ \partial_\theta f^{\alpha\prime}{}_\theta - \partial_\alpha f_{\prime\theta}\ \partial^\theta f^{\alpha\prime} + \partial_\prime f_{\alpha\theta}\ \partial^\theta f^{\alpha\prime} + \partial_\theta f_\alpha{}^\theta\ \partial_\prime f^{\alpha\prime} + \partial_\theta f_{\prime\alpha}\ \partial^\theta f^{\alpha\prime} + 2\,\mathcal{A}_{\alpha\theta}\ (\mathcal{A}^{\alpha\prime\theta} + 2\,\partial^\theta f^{\alpha\prime})) - \frac{1}{3} r_1 (3\,\partial_\beta \mathcal{A}_\prime{}^\theta{}_{,\theta}\ \partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha - 3\,\partial_\prime \mathcal{A}_\beta{}^\theta{}_{,\theta}\ \partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha - 3\,\partial_\alpha \mathcal{A}^{\alpha\beta\prime}\ \partial_\theta \mathcal{A}_\beta{}^\theta{}_{,\prime} + 3\,\partial_\alpha \mathcal{A}^{\alpha\beta\prime}\ \partial_\theta \mathcal{A}_\prime{}^\theta{}_{,\beta} - 6\,\partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha\ \partial_\theta \mathcal{A}_\prime{}^\theta{}_{,\beta} + 4\,\partial_\beta \mathcal{A}_{\alpha\prime\theta}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime} - 2\,\partial_\beta \mathcal{A}_{\alpha\theta\prime}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime} + 8\,\partial_\beta \mathcal{A}_{\prime\theta\alpha}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime} + 2\,\partial_\prime \mathcal{A}_{\alpha\beta\theta}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime} - 2\,\partial_\theta \mathcal{A}_{\alpha\beta\prime}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime} - 2\,\partial_\theta \mathcal{A}_{\alpha\prime\beta}\ \partial^\theta \mathcal{A}^{\alpha\beta\prime}))[t, x, y, z]\,dz\,dy\,dx\,dt$$

$\sigma_{1^+}^{\#1\,\alpha\beta}\dagger$

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\dagger$	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
$\sigma_{1^+}^{\#2\,\alpha\beta}\dagger$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{2k^2 r_1+t_1}{(1+k^2)^2 t_1^2}$	$-\frac{i(2k^3 r_1+k t_1)}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$\frac{i(2k^3 r_1+k t_1)}{(1+k^2)^2 t_1^2}$	$\frac{-2k^4 r_1+k^2 t_1}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	0	$\frac{2ik}{t_1+2k^2 t_1}$
$\sigma_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	$\frac{1}{(1+2k^2)^2 t_1}$	0	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$
$\tau_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$-\frac{2ik}{t_1+2k^2 t_1}$	0	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$\frac{2k^2}{(1+2k^2)^2 t_1}$

$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}\dagger$

	$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{1^-}^{\#1\,\alpha}$	$\mathcal{A}_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}\dagger$	$k^2 r_1 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\mathcal{A}_{1^+}^{\#2\,\alpha\beta}\dagger$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\mathcal{A}_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	$\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	ikt_1
$\mathcal{A}_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	$-ikt_1$
$f_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	$-ikt_1$	0	$-ikt_1$	0

$\sigma_{0^+}^{\#1}\dagger$

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

$\sigma_{2^+}^{\#1\,\alpha\beta}\dagger$

	$\sigma_{2^+}^{\#1\,\alpha\beta}$	$\tau_{2^+}^{\#1\,\alpha\beta}$	$\sigma_{2^-}^{\#1\,\alpha\beta\chi}$
$\sigma_{2^+}^{\#1\,\alpha\beta}\dagger$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0
$\tau_{2^+}^{\#1\,\alpha\beta}\dagger$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0
$\sigma_{2^-}^{\#1\,\alpha\beta\chi}\dagger$	0	0	$\frac{2}{2k^2 r_1+t_1}$

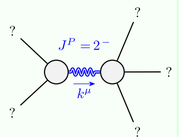
$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}\dagger$

	$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}$	$f_{2^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{2^-}^{\#1\,\alpha\beta\chi}$
$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}\dagger$	$\frac{t_1}{2}$	$\frac{ikt_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1\,\alpha\beta}\dagger$	$-\frac{ikt_1}{\sqrt{2}}$	$k^2 t_1$	0
$\mathcal{A}_{2^-}^{\#1\,\alpha\beta\chi}\dagger$	0	0	$k^2 r_1 + \frac{t_1}{2}$

$\mathcal{A}_{0^+}^{\#1}\dagger$

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

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2 r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particle)

Unitarity conditions

$r_1 < 0$ && $t_1 > 0$