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

Quadratic (free) action

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

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

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

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

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

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

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

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

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

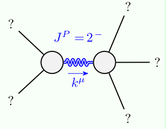
$\mathcal{R}_{0^+}^{\#1}\,\dagger$

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

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

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

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 particles)

Unitarity conditions

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