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
$\tau_{0^+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha{}_\alpha$	1
$\tau_{1^+}^{\#2\,\alpha} + 2\,i\,k\,\sigma_{1^+}^{\#1\,\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^\alpha{}_\gamma \tau^{\beta\chi} + 2\,(\partial_\sigma \partial_\chi \partial_\alpha \sigma^{\sigma\beta\chi} - \partial_\sigma \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} + \partial_\sigma \partial_\chi \partial^\chi \sigma^{\alpha\beta}{}_\beta) == \partial_\chi \partial^\chi \partial_\rho \tau^{\alpha\rho}$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^\alpha{}_\gamma \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3
$\sigma_{1^-}^{\#1\,\alpha} == \sigma_{1^-}^{\#2\,\alpha}$	$\partial_\alpha \sigma^{\alpha\beta}{}_\beta + \partial_\chi \partial^\chi \sigma^{\alpha\beta}{}_\beta == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	$\partial_\chi \sigma^{\alpha\chi}{}_\gamma \tau^{\gamma\beta} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\sigma \partial_\chi \sigma^{\sigma\alpha\chi}{}_\delta \tau^{\delta\beta} + 2\,\partial_\sigma \partial_\chi \sigma^{\sigma\beta\chi}{}_\delta \tau^{\delta\alpha} == \partial_\chi \partial^\chi \tau^{\alpha\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\alpha \tau^{\beta\chi} + 2\,\partial_\sigma \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\tau_{2^+}^{\#1\,\alpha\beta} - 2\,i\,k\,\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	$-i\,(4\,\partial_\sigma \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\sigma \partial^\delta \partial^\beta \partial^\alpha \tau^\chi{}_\chi - 3\,\partial_\sigma \partial^\delta \partial_\chi \partial^\alpha \tau^{\chi\beta} - 3\,\partial_\sigma \partial^\delta \partial_\chi \partial^\beta \tau^{\chi\alpha} + 3\,\partial_\sigma \partial^\delta \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\sigma \partial^\delta \partial_\chi \partial^\chi \tau^{\beta\alpha} + 4\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta\epsilon}{}_\delta - 6\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\alpha \sigma^{\beta\delta\epsilon} - 6\,i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \sigma^{\alpha\delta\epsilon} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \tau^{\chi\delta} + 6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\beta\delta} + 6\,i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\delta\alpha} - 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau^\chi{}_\chi - 4\,i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta\epsilon}{}_\delta) == 0$	5
Total constraints/gauge generators:		19

Quadratic (free) action

$$S == \iiint\!\!\int \tfrac{1}{6}\,(2\,t_1\,\mathcal{R}^{\alpha\prime}{}_\alpha{}^\theta{}_{,\theta} + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\mathcal{R}^{a\beta\chi}\,\sigma_{\alpha\beta\chi} - 4\,t_1\,\mathcal{R}_{,\alpha}{}^\theta{}_\theta\,\partial_\prime f^{\alpha\prime} + 4\,t_1\,\mathcal{R}_{,\theta}{}^\theta{}_\alpha\,\partial^\prime f^{\alpha}{}_{\prime} - 2\,t_1\,\partial_{,f}{}^\theta{}_\theta\,\partial^\prime f^\alpha{}_\alpha - 24\,r_3\,\partial_\beta \mathcal{R}_{,\theta}{}^\theta{}_\alpha\,\partial^\prime \mathcal{R}^{\alpha\beta}{}_\alpha - 2\,t_1\,\partial_{,f}{}^{\alpha\prime}{}_\theta\,\partial_\theta f^\alpha{}_{\alpha\prime} + 4\,t_1\,\partial_{,f}{}^\theta{}_\alpha\,\partial_\theta f^\alpha{}_{\theta\prime} - 24\,r_3\,\partial_\alpha \mathcal{R}^{\alpha\beta}{}_{,\theta}{}^\theta{}_\beta\,\partial_\theta \mathcal{R}^\theta{}_{\alpha\prime} + 48\,r_3\,\partial^\prime \mathcal{R}^{\alpha\beta}{}_\alpha{}^\theta{}_{,\theta}\,\partial_\theta \mathcal{R}^\theta{}_{\beta\prime} + 4\,t_1\,\mathcal{R}_{,\theta\alpha}\,\partial^\theta f^{\alpha\prime} + 4\,t_2\,\mathcal{R}_{,\theta\alpha}\,\partial^\theta f^{\alpha\prime} - 4\,t_1\,\partial_{\alpha\prime}{}_{,\theta}\,\partial^\theta f^{\alpha\prime} + 2\,t_2\,\partial_{\alpha\prime}{}_{,\theta}\,\partial^\theta f^{\alpha\prime} - 4\,t_1\,\partial_{\alpha\prime}{}_{\theta,}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_{\alpha\prime}{}_{\theta,}\,\partial^\theta f^{\alpha\prime} + 2\,t_1\,\partial_{,f}{}_{\alpha\theta}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_{,f}{}_{\alpha\theta}\,\partial^\theta f^{\alpha\prime} + 4\,t_1\,\partial_{\theta f}{}_{\alpha\prime}\,\partial^\theta f^{\alpha\prime} + t_2\,\partial_{\theta f}{}_{\alpha\prime}\,\partial^\theta f^{\alpha\prime} + 2\,t_1\,\partial_{\theta f}{}_{,\alpha}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_{\theta f}{}_{,\alpha}\,\partial^\theta f^{\alpha\prime} + 2\,(t_1+t_2)\,\mathcal{R}_{,\alpha\prime\theta}\,(\mathcal{R}^{\alpha\prime\theta} + 2\,\partial^\theta f^{\alpha\prime}) + 2\,\mathcal{R}_{,\alpha\theta\prime}\,((t_1-t_2)\,\mathcal{R}^{\alpha\prime\theta} + 2\,(2\,t_1-t_2)\,\partial^\theta f^{\alpha\prime}) + 8\,r_2\,\partial_\beta \mathcal{R}_{,\alpha\prime\theta}\,\partial^\theta \mathcal{R}^{\alpha\beta\prime} - 4\,r_2\,\partial_\beta \mathcal{R}_{,\alpha\theta\prime}\,\partial^\theta \mathcal{R}^{\alpha\beta\prime} + 4\,r_2\,\partial_\beta \mathcal{R}_{,\theta\alpha}\,\partial^\theta \mathcal{R}^{\alpha\beta\prime} - 24\,r_3\,\partial_\beta \mathcal{R}_{,\theta\alpha}\,\partial^\theta \mathcal{R}^{\alpha\beta\prime} - 2\,r_2\,\partial_\alpha \mathcal{R}_{,\alpha\beta\theta}\,\partial^\theta \mathcal{R}^{\alpha\beta\prime} + 2\,r_2\,\partial_\alpha \mathcal{R}_{,\alpha\beta\theta}\,\partial^\beta \mathcal{R}^{\alpha\theta\prime} - 4\,r_2\,\partial_\theta \mathcal{R}_{,\alpha\beta}\,\partial^\theta \mathcal{R}^{\alpha\beta\prime})\,[t,\,x,\,y,\,z]\,dz\,dy\,dx\,dt$$

$\sigma_{1^+}^{\#1\,\alpha\beta}$ †

$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\frac{2\,(t_1+t_2)}{3\,t_1\,t_2}$	$\frac{\sqrt{2}\,(t_1-2\,t_2)}{3\,(1+k^2)\,t_1\,t_2}$	$\frac{i\,\sqrt{2}\,k\,(t_1-2\,t_2)}{3\,(1+k^2)\,t_1\,t_2}$	0	0	0	0
$\frac{\sqrt{2}\,(t_1-2\,t_2)}{3\,(1+k^2)\,t_1\,t_2}$	$\frac{t_1+4\,t_2}{3\,(1+k^2)\,t_1\,t_2}$	$\frac{i\,k\,(t_1+4\,t_2)}{3\,(1+k^2)\,t_1\,t_2}$	0	0	0	0
$-\frac{i\,\sqrt{2}\,k\,(t_1-2\,t_2)}{3\,(1+k^2)\,t_1\,t_2}$	$-\frac{i\,k\,(t_1+4\,t_2)}{3\,(1+k^2)\,t_1\,t_2}$	$\frac{k^2\,(t_1+4\,t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$	0	$\frac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_1}$	$\frac{12\,i\,k}{(3+4\,k^2)^2\,t_1}$	$\frac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_1}$
0	0	0	0	$\frac{6\,\sqrt{2}}{(3+4\,k^2)^2\,t_1}$	$\frac{12}{(3+4\,k^2)^2\,t_1}$	$\frac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_1}$
0	0	0	0	0	0	0
0	0	0	0	$-\frac{12\,i\,k}{(3+4\,k^2)^2\,t_1}$	$-\frac{12\,i\,\sqrt{2}\,k}{(3+4\,k^2)^2\,t_1}$	$\frac{24\,k^2}{(3+4\,k^2)^2\,t_1}$

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

$\mathcal{R}_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{R}_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{R}_{1^-}^{\#1\,\alpha}$	$\mathcal{R}_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\frac{1}{6}\,(t_1+4\,t_2)$	$-\frac{t_1-2\,t_2}{3\,\sqrt{2}}$	$-\frac{i\,k\,(t_1-2\,t_2)}{3\,\sqrt{2}}$	0	0	0	0
$-\frac{t_1-2\,t_2}{3\,\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}\,i\,k\,(t_1+t_2)$	0	0	0	0
$\frac{i\,k\,(t_1-2\,t_2)}{3\,\sqrt{2}}$	$-\frac{1}{3}\,i\,k\,(t_1+t_2)$	$\frac{1}{3}\,k^2\,(t_1+t_2)$	0	$\frac{t_1}{3\,\sqrt{2}}$	$\frac{i\,k\,t_1}{3}$	0
0	0	0	$\frac{t_1}{6}$	$\frac{t_1}{3}$	0	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_1$
0	0	0	$-\frac{t_1}{3\,\sqrt{2}}$	0	0	0
0	0	0	0	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_1$	0	$\frac{2\,k^2\,t_1}{3}$

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

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

$\mathcal{A}_{0^+}^{\#1}$ †

$\mathcal{A}_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\mathcal{A}_{0^-}^{\#1}$
$6\,k^2\,r_3$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2\,r_2 + t_2$

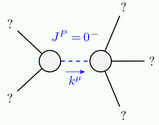
$\sigma_{0^+}^{\#1}$ †

$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\frac{1}{6\,k^2\,r_3}$	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2\,r_2+t_2}$

$\sigma_{2^+}^{\#1}$ †

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

Massive and massless spectra



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

(No massless particles)

Unitarity conditions

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