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
$\tau_{0^+}^{\#1} - 2\,i\,k\,\sigma_{0^+}^{\#1} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == \partial_\beta \partial^\beta \tau^\alpha{}_\alpha + 2\,\partial_\chi \partial^\chi \partial_\rho \sigma^{\alpha\beta}{}_\alpha$	1
$\tau_{1^-}^{\#2\,\alpha} - i\,k\,\sigma_{1^-}^{\#1\,\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\#1}{}_\alpha{}^{\beta\chi} == \partial_\chi \partial^\chi \partial_\rho \tau^{\alpha\beta}{}_\alpha + \partial_\alpha \partial^\beta \partial_\chi \sigma^{\alpha\chi}{}_\beta + \partial_\alpha \partial^\beta \partial_\chi \sigma^{\alpha\chi}{}_\beta$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\#1}{}_\alpha{}^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3
$\sigma_{1^+}^{\#1\,\alpha} + 2\,\sigma_{1^+}^{\#2\,\alpha} == 0$	$\partial_\chi \partial^\alpha \sigma^{\beta\chi}{}_\beta + \partial_\chi \partial^\chi \sigma^{\alpha\beta}{}_\beta == 3\,\partial_\chi \partial_\rho \sigma^{\alpha\beta\chi}$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\alpha\beta} + 2\,\partial_\rho \partial_\chi \partial^\beta \sigma^{\alpha\chi}{}_\delta + 2\,\partial_\rho \partial^\alpha \sigma^{\beta\chi}{}_\delta + 2\,\partial_\rho \partial^\beta \sigma^{\alpha\chi}{}_\delta == \partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha} + 2\,\partial_\rho \partial_\chi \sigma^{\beta\rho}{}_\delta{}^{\alpha\chi}$	3
$\sigma_{2^+}^{\#1\,\alpha\beta\chi} == 0$	$3\,\partial_\epsilon \partial_\delta \partial^\chi \partial^\alpha \sigma^{\beta\delta\epsilon} + 3\,\partial_\epsilon \partial^\epsilon \partial^\chi \partial^\alpha \sigma^{\beta\delta}{}_\delta + 2\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\chi\delta} + 4\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\beta\delta} + 4\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\beta\delta} + 2\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 3\,\eta^{\beta\chi}\,\partial_\epsilon \partial_\delta \partial^\alpha \sigma^{\delta\epsilon}{}_\delta + 3\,\eta^{\alpha\chi}\,\partial_\epsilon \partial_\delta \partial^\beta \sigma^{\delta\epsilon}{}_\delta + 3\,\eta^{\beta\chi}\,\partial_\epsilon \partial_\delta \partial^\epsilon \sigma^{\alpha\delta}{}_\delta == 3\,\partial_\epsilon \partial_\delta \partial^\chi \partial^\epsilon \sigma^{\alpha\beta\delta} + 3\,\partial_\epsilon \partial^\epsilon \partial^\chi \partial^\delta \sigma^{\alpha\beta}{}_\delta + 2\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\chi\delta} + 2\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 4\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\beta\delta} + 2\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\alpha\chi\beta} + 3\,\eta^{\alpha\chi}\,\partial_\epsilon \partial^\epsilon \partial^\beta \sigma^{\delta\epsilon}{}_\delta + 3\,\eta^{\beta\chi}\,\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon} + 3\,\eta^{\alpha\chi}\,\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta}{}_\delta$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	$4\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \tau^{\chi\delta} + 2\,\partial_\epsilon \partial^\epsilon \partial^\beta \partial^\alpha \tau^\chi{}_\chi + 3\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\alpha \tau^{\beta\chi} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\chi \tau^{\delta\epsilon} == 3\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\chi \tau^{\alpha\beta} + 3\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\beta \tau^{\alpha\chi} + 3\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\alpha \tau^{\beta\chi} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\chi \partial^\chi \tau^\delta{}_\delta$	5
Total constraints/gauge generators:		24

Quadratic (free) action

$$S == \int\int\int\int \frac{1}{6}\,(-4\,t_3\,\omega^{\alpha\prime}{}_\alpha\,\omega^{\alpha\prime}{}_\kappa + 6\,f^{\alpha\beta}{}_\kappa\,\tau_{\alpha\beta} + 6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} + 8\,t_3\,\omega^\kappa{}_\alpha\,\partial_\kappa f^{\alpha\prime}{}_\alpha - 8\,t_3\,\omega^\kappa{}_\alpha\,\partial^\alpha f^\kappa{}_\alpha + 4\,t_3\,\partial_\kappa f^\kappa{}_\alpha\,\partial^\alpha f^\kappa{}_\alpha - 6\,r_3\,\partial_\beta \omega^\alpha{}_\theta\,\partial^\beta \omega^{\alpha\theta}{}_\alpha - 6\,r_3\,\partial_\alpha \omega^{\alpha\beta}{}_\theta\,\partial_\theta \omega^\theta{}_\beta + 12\,r_3\,\partial \omega^{\alpha\beta}{}_\alpha\,\partial_\theta \omega^\theta{}_\beta + 4\,t_2\,\omega_{\iota\theta\alpha}\,\partial^\theta f^{\alpha\prime} + 2\,t_2\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\alpha f_\theta\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\iota f_{\alpha\theta}\,\partial^\theta f^{\alpha\prime} + t_2\,\partial_\theta f_{\alpha\prime}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\prime} + 4\,t_2\,\omega_{\alpha\theta\prime}\,(\omega^{\alpha\prime\theta} + \partial^\theta f^{\alpha\prime}) + 2\,t_2\,\omega_{\alpha\prime\theta}\,(\omega^{\alpha\prime\theta} + 2\,\partial^\theta f^{\alpha\prime}) + 8\,r_2\,\partial_\theta \omega_{\alpha\prime\theta}\,\partial^\theta \omega^{\alpha\theta\prime} - 4\,r_2\,\partial_\theta \omega_{\theta\prime\theta}\,\partial^\theta \omega^{\alpha\theta\prime} + 4\,r_2\,\partial_\theta \omega_{\theta\alpha}\,\partial^\theta \omega^{\alpha\theta\prime} - 24\,r_3\,\partial_\theta \omega_{\prime\theta\alpha}\,\partial^\theta \omega^{\alpha\theta\prime} - 2\,r_2\,\partial_\iota \omega_{\alpha\theta\theta}\,\partial^\theta \omega^{\alpha\theta\prime} + 2\,r_2\,\partial_\theta \omega_{\alpha\theta\prime}\,\partial^\theta \omega^{\alpha\theta\prime} + 4\,t_3\,\partial_\iota f^{\alpha\prime}{}_\alpha\,\partial_\kappa f^{\alpha\prime}{}_\kappa - 8\,t_3\,\partial^\iota f^\alpha{}_\alpha\,\partial_\kappa f^\kappa{}_\iota)[t, x, y, z]\,dz\,dy\,dx\,dt$$

$\sigma_{1^-}^{\#1\,\alpha}\dagger\,\sigma_{1^-}^{\#1\,\alpha}$

$\frac{2}{3\,k^2\,r_3}$	$-\frac{2\,\sqrt{2}}{3\,k^2\,r_3+3\,k^4\,r_3}$	$-\frac{2\,i\,\sqrt{2}}{3\,k\,r_3+3\,k^3\,r_3}$	0
$-\frac{2\,\sqrt{2}}{3\,k^2\,r_3+3\,k^4\,r_3}$	$\frac{9\,k^2\,r_3+4\,t_2}{3\,(k+k^3)^2\,r_3\,t_2^2}$	$\frac{i\,(9\,k^2\,r_3+4\,t_2)}{3\,k\,(1+k^2)^2\,r_3\,t_2^2}$	0
$-\frac{2\,i\,\sqrt{2}}{3\,k\,r_3+3\,k^3\,r_3}$	$-\frac{i\,(9\,k^2\,r_3+4\,t_2)}{3\,k\,(1+k^2)^2\,r_3\,t_2^2}$	$\frac{9\,k^2\,r_3+4\,t_2}{3\,(1+k^2)^2\,r_3\,t_2^2}$	0
0	0	0	$\frac{6}{(3+2\,k^2)^2\,t_3}$
0	0	0	$-\frac{3\,\sqrt{2}}{(3+2\,k^2)^2\,t_3}$
0	0	0	$\frac{6\,i\,k}{(3+2\,k^2)^2\,t_3}$

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

0	0	0	0
0	0	0	0
0	0	0	0
$-\frac{6}{(3+2\,k^2)^2\,t_3}$	$\frac{3\,\sqrt{2}}{(3+2\,k^2)^2\,t_3}$	$-\frac{6\,i\,k}{(3+2\,k^2)^2\,t_3}$	0
$\frac{3\,\sqrt{2}}{(3+2\,k^2)^2\,t_3}$	$-\frac{3}{(3+2\,k^2)^2\,t_3}$	$\frac{3\,i\,\sqrt{2}\,k}{(3+2\,k^2)^2\,t_3}$	0
$-\frac{6\,i\,k}{(3+2\,k^2)^2\,t_3}$	$\frac{3\,i\,\sqrt{2}\,k}{(3+2\,k^2)^2\,t_3}$	$-\frac{6\,k^2}{(3+2\,k^2)^2\,t_3}$	0

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

$\frac{1}{6}\,(9\,k^2\,r_3+4\,t_2)$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{i\,k\,t_2}{3}$	$\frac{2\,t_3}{3}$
$\frac{\sqrt{2}\,t_2}{3}$	$\frac{t_2}{3}$	$-\frac{1}{3}\,i\,k\,t_2$	$-\frac{\sqrt{2}\,t_3}{3}$
$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	$\frac{k^2\,t_2}{3}$	$\frac{2\,i\,k\,t_2}{3}$	$\frac{t_3}{3}$
0	0	0	$\frac{2\,k^2\,t_3}{3}$

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

0	0	0	$\frac{2\,t_3}{3}$
0	0	0	$-\frac{\sqrt{2}\,t_3}{3}$
0	0	0	$\frac{2\,i\,t_3}{3}$

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

0	0	0	$-\frac{\sqrt{2}\,t_3}{3}$
0	0	0	$\frac{t_3}{3}$
0	0	0	$-\frac{i\,k\,t_3}{3}$

$\omega_{1^+}^{\#1\,\alpha\beta}\dagger\,f_{1^-}^{\#1\,\alpha}$

0	0	0	$-\frac{2}{3}\,i\,k\,t_3$
0	0	0	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$
0	0	0	0
0	0	0	0

$\omega_{1^+}^{\#1\,\alpha\beta}\dagger\,f_{1^-}^{\#2\,\alpha}$

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$\frac{2\,i\,k^2\,t_3}{3}$

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

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$\frac{2\,k^2\,t_3}{3}$

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

$-\frac{3\,k^2\,r_3}{2}$	0	0	
0	0	0	
0	0	0	

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

$\frac{1}{(1+2\,k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	0	0
$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_3}$	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2\,r_2+t_2}$

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

0	0	0	0
$-i\,\sqrt{2}\,k\,t_3$	$2\,k^2\,t_3$	0	0
t_3	$i\,\sqrt{2}\,k\,t_3$	0	0
0	0	0	$k^2\,r_2+t_2$

$\sigma_{0^+}^{\#1}\dagger\,\tau_{0^+}^{\#2}$

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2\,r_2+t_2$

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

0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2\,r_2+t_2$

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

$-\frac{2}{3\,k^2\,r_3}$	0	0	
0	0	0	
0	0	0	

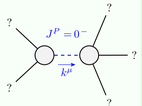
$\tau_{2^+}^{\#1\,\alpha\beta}\dagger\,\tau_{2^+}^{\#1\,\alpha\beta}$

0	0	0	
0	0	0	
0	0	0	

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

0	0	0	
0	0	0	
0	0	0	

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

$r_2 < 0 \;\&\&\; t_2 > 0$