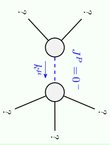
Particle spectrograph

Wave operator and propagator

Massive and massless spectra



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

(No massless particles)

Unitarity conditions

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

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

Quadratic (free) action

$$\mathcal{S} == \iiiint \Big(\frac{1}{6}\,(-4\,t_3\,\mathcal{A}^{\alpha\prime}{}_\alpha\,\mathcal{A}_\prime{}^\theta{}_\theta + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\mathcal{A}^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} + 8\,t_3\,\mathcal{A}_\alpha{}^\theta{}_\theta\,\partial_\prime f^{\alpha\prime} - 8\,t_3\,\mathcal{A}_\prime{}^\theta{}_\theta\,\partial^\prime f^\alpha{}_\alpha + 4\,t_3\,\partial_\prime f^\theta{}_\theta\,\partial^\prime f^\alpha{}_\alpha - 15\,r_3\,\partial_\beta \mathcal{A}_\prime{}^\theta{}_\theta\,\partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha + 9\,r_3\,\partial_\prime \mathcal{A}_\beta{}^\theta{}_\theta\,\partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha + 4\,t_3\,\partial_\prime f^{\alpha\prime}\,\partial_\theta f_\alpha{}^\theta - 8\,t_3\,\partial^\prime f^\alpha{}_\alpha\,\partial_\theta f_\prime{}^\theta + 9\,r_3\,\partial_\alpha \mathcal{A}^{\alpha\beta\prime}\,\partial_\theta \mathcal{A}_\beta{}^\theta{}_\prime - 18\,r_3\,\partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha\,\partial_\theta \mathcal{A}_\beta{}^\theta{}_\prime - 15\,r_3\,\partial_\alpha \mathcal{A}^{\alpha\beta\prime}\,\partial_\theta \mathcal{A}_\prime{}^\theta{}_\beta + 30\,r_3\,\partial^\prime \mathcal{A}^{\alpha\beta}{}_\alpha\,\partial_\theta \mathcal{A}_\prime{}^\theta{}_\beta + 4\,t_2\,\mathcal{A}_{\prime\theta\alpha}\,\partial^\theta f^{\alpha\prime} + 2\,t_2\,\partial_\alpha f_{\prime\theta}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\alpha f_{\theta\prime}\,\partial^\theta f^{\alpha\prime} - t_2\,\partial_\prime 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_{\prime\alpha}\,\partial^\theta f^{\alpha\prime} - 4\,t_2\,\mathcal{A}_{\alpha\theta\prime}\,(\mathcal{A}^{\alpha\prime\theta} + \partial^\theta f^{\alpha\prime}) + 2\,t_2\,\mathcal{A}_{\alpha\prime\theta}\,(\mathcal{A}^{\alpha\prime\theta} + 2\,\partial^\theta f^{\alpha\prime}) + 8\,r_2\,\partial_\beta \mathcal{A}_{\alpha\prime\theta}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime} - 4\,r_2\,\partial_\beta \mathcal{A}_{\alpha\theta\prime}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime} + 4\,r_2\,\partial_\beta \mathcal{A}_{\prime\theta\alpha}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime} - 24\,r_3\,\partial_\beta \mathcal{A}_{\prime\theta\alpha}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime} - 2\,r_2\,\partial_\prime \mathcal{A}_{\alpha\beta\theta}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime} + 2\,r_2\,\partial_\theta \mathcal{A}_{\alpha\beta\prime}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime} - 4\,r_2\,\partial_\theta \mathcal{A}_{\alpha\prime\beta}\,\partial^\theta \mathcal{A}^{\alpha\beta\prime}\Big)[t,\,x,\,y,\,z]\,dt\,dz\,dy\,dx\,dt$$

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\dagger\,\alpha\beta}$	$\frac{6}{(3+k^2)^2 t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\dagger\,\alpha\beta}$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3}{(3+k^2)^2 t_2}$	$\frac{3\,i\,k}{(3+k^2)^2 t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\dagger\,\alpha\beta}$	$-\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2 t_2}$	$-\frac{3\,i\,k}{(3+k^2)^2 t_2}$	$\frac{3\,k^2}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\dagger\,\alpha}$	0	0	0	$-\frac{2}{3\,k^2 r_3}$	$-\frac{2\sqrt{2}}{3\,k^2 r_3 + 6\,k^4 r_3}$	0	$-\frac{4\,i}{3\,k\,r_3 + 6\,k^3 r_3}$
$\sigma_{1^-}^{\#2\,\dagger\,\alpha}$	0	0	0	$-\frac{2\sqrt{2}}{3\,k^2 r_3 + 6\,k^4 r_3}$	$\frac{9\,k^2 r_3 \cdot 4\,t_3}{3\,(k+2\,k^3)^2 r_3\,t_3}$	0	$\frac{i\,\sqrt{2}\,(9\,k^2 r_3 \cdot 4\,t_3)}{3\,k\,(1+2\,k^2)^2 r_3\,t_3}$
$\tau_{1^-}^{\#1\,\dagger\,\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\dagger\,\alpha}$	0	0	0	$\frac{4\,i}{3\,k\,r_3 + 6\,k^3 r_3}$	$-\frac{i\,\sqrt{2}\,(9\,k^2 r_3 \cdot 4\,t_3)}{3\,k\,(1+2\,k^2)^2 r_3\,t_3}$	0	$\frac{2\,(9\,k^2 r_3 \cdot 4\,t_3)}{3\,(1+2\,k^2)^2 r_3\,t_3}$

	$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{1^-}^{\#1\,\alpha}$	$\mathcal{A}_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\mathcal{A}_{1^+}^{\#1\,\dagger\,\alpha\beta}$	$\frac{2\,t_2}{3}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	0	0	0	0
$\mathcal{A}_{1^+}^{\#2\,\dagger\,\alpha\beta}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{t_2}{3}$	$\frac{i\,k\,t_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\dagger\,\alpha\beta}$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	$-\frac{1}{3}\,i\,k\,t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\mathcal{A}_{1^-}^{\#1\,\dagger\,\alpha}$	0	0	0	$\frac{1}{6}\,(-9\,k^2 r_3 + 4\,t_3)$	$-\frac{\sqrt{2}\,t_3}{3}$	0	$-\frac{2}{3}\,i\,k\,t_3$
$\mathcal{A}_{1^-}^{\#2\,\dagger\,\alpha}$	0	0	0	$-\frac{\sqrt{2}\,t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$
$f_{1^-}^{\#1\,\dagger\,\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\dagger\,\alpha}$	0	0	0	$\frac{2\,i\,k\,t_3}{3}$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$	0	$\frac{2\,k^2 t_3}{3}$

	$\sigma_{0^+}^{\#1\,\dagger}$	$\tau_{0^+}^{\#1\,\dagger}$	$\tau_{0^+}^{\#2\,\dagger}$	$\sigma_{0^+}^{\#1}$
$\sigma_{0^+}^{\#1}$	0	0	0	0
$\tau_{0^+}^{\#1}$	0	0	0	$\frac{1}{(1+2\,k^2)^2 t_3}$
$\tau_{0^+}^{\#2}$	0	0	0	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2 t_3}$
$\sigma_{0^+}^{\#1}$	0	$\frac{1}{(1+2\,k^2)^2 t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2 t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2 t_3}$

	$\mathcal{A}_{0^+}^{\#1\,\dagger}$	$f_{0^+}^{\#1\,\dagger}$	$f_{0^+}^{\#2\,\dagger}$	$\mathcal{A}_{0^+}^{\#1}$
$\mathcal{A}_{0^+}^{\#1}$	0	0	0	t_3
$f_{0^+}^{\#1}$	0	0	0	$i\,\sqrt{2}\,k\,t_3$
$f_{0^+}^{\#2}$	0	0	0	$-i\,\sqrt{2}\,k\,t_3$
$\mathcal{A}_{0^+}^{\#1}$	0	0	0	$k^2 r_2 + t_2$

	$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}$	$f_{2^+}^{\#1\,\alpha\beta}$	$\mathcal{A}_{2^-}^{\#1\,\alpha\beta\chi}$
$\mathcal{A}_{2^+}^{\#1\,\dagger\,\alpha\beta}$	$-\frac{3\,k^2 r_3}{2}$	0	0
$f_{2^+}^{\#1\,\dagger\,\alpha\beta}$	0	0	0
$\mathcal{A}_{2^-}^{\#1\,\dagger\,\alpha\beta\chi}$	0	0	0

	$\sigma_{2^+}^{\#1\,\dagger\,\alpha\beta}$	$\tau_{2^+}^{\#1\,\dagger\,\alpha\beta}$	$\sigma_{2^+}^{\#1\,\alpha\beta}$
$\sigma_{2^+}^{\#1\,\alpha\beta}$	0	0	$-\frac{2}{3\,k^2 r_3}$
$\tau_{2^+}^{\#1\,\alpha\beta}$	0	0	0
$\sigma_{2^+}^{\#1\,\alpha\beta}$	0	0	0

	$\sigma_{2^-}^{\#1\,\dagger\,\alpha\beta\chi}$
$\sigma_{2^-}^{\#1\,\alpha\beta\chi}$	0
$\tau_{2^+}^{\#1\,\alpha\beta}$	0
$\sigma_{2^+}^{\#1\,\alpha\beta}$	0