

Particle spectrograph

Wave operator and propagator

$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2^-}^{\#1} \dagger^{\alpha\beta\chi}$	$\omega_{0^+}^{\#1} \dagger$	$f_{0^+}^{\#1} \dagger$	$f_{0^+}^{\#2} \dagger$	$\omega_{0^-}^{\#1} \dagger$	$\omega_{2^+}^{\#1} \dagger^{\alpha\beta}$	$f_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{2^-}^{\#1} \dagger^{\alpha\beta\chi}$			
$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$	0	$\omega_{0^+}^{\#1} \dagger$	t_3	$-i\sqrt{2}kt_3$	0	0	$\omega_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ik t_1}{\sqrt{2}}$	0
$\tau_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0	$f_{0^+}^{\#1} \dagger$	$i\sqrt{2}kt_3$	$2k^2 t_3$	0	0	$f_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{ik t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\sigma_{2^-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$\frac{2}{t_1}$	$f_{0^+}^{\#2} \dagger$	0	0	0	0	$\omega_{2^-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$\frac{t_1}{2}$
				$\omega_{0^-}^{\#1} \dagger$	0	0	0	$-t_1$				

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

$\omega_{1+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{1+}^{\#2}\dagger^{\alpha\beta}$	$f_{1+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{1-}^{\#1}\dagger^\alpha$	$\omega_{1-}^{\#2}\dagger^\alpha$	$f_{1-}^{\#1}\dagger^\alpha$	$f_{1-}^{\#2}\dagger^\alpha$
$\omega_{1+}^{\#1}\dagger^{\alpha\beta}$	$k^2\,r_5 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{i\,k\,t_1}{\sqrt{2}}$	0	0	0
$\omega_{1+}^{\#2}\dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0
$f_{1+}^{\#1}\dagger^{\alpha\beta}$	$\frac{i\,k\,t_1}{\sqrt{2}}$	0	0	0	0	0
$\omega_{1-}^{\#1}\dagger^\alpha$	0	0	0	$\frac{1}{6}\,(6\,k^2\,r_5 + t_1 + 4\,t_3)$	$\frac{t_1-2\,t_3}{3\,\sqrt{2}}$	0
$\omega_{1-}^{\#2}\dagger^\alpha$	0	0	0	$\frac{t_1-2\,t_3}{3\,\sqrt{2}}$	$\frac{t_1+t_3}{3}$	$\frac{1}{3}\,i\,k\,(t_1-2\,t_3)$
$f_{1-}^{\#1}\dagger^\alpha$	0	0	0	0	0	0
$f_{1-}^{\#2}\dagger^\alpha$	0	0	0	$-\frac{1}{3}\,i\,k\,(t_1-2\,t_3)$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,(t_1+t_3)$	0

$\sigma_{0+}^{\#1}\dagger$	$\tau_{0+}^{\#1}\dagger$	$\sigma_{0+}^{\#2}\dagger$	$\tau_{0+}^{\#2}\dagger$	$\sigma_{0-}^{\#1}\dagger$	$\tau_{0-}^{\#1}\dagger$
$\sigma_{0+}^{\#1}\dagger$	$\frac{1}{(1+2\,k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	0	0
$\tau_{0+}^{\#1}\dagger$	$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_3}$	0	0
$\sigma_{0+}^{\#2}\dagger$	0	0	0	0	0
$\tau_{0+}^{\#2}\dagger$	0	0	0	$-\frac{1}{t_1}$	$\frac{1}{t_1}$

$\sigma_{1+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2}\dagger^{\alpha\beta}$	$\tau_{1+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1-}^{\#1}\dagger^\alpha$	$\sigma_{1-}^{\#2}\dagger^\alpha$	$\tau_{1-}^{\#1}\dagger^\alpha$	$\tau_{1-}^{\#2}\dagger^\alpha$
$\sigma_{1+}^{\#1}\dagger^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2\,t_1}$	$-\frac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1}$	0	0	0
$\sigma_{1+}^{\#2}\dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2\,t_1}$	$\frac{-2\,k^2\,r_5+t_1}{(1+k^2)^2\,t_1^2}$	$-\frac{i\,(2\,k^3\,r_5-k\,t_1)}{(1+k^2)^2\,t_1^2}$	0	0	0
$\tau_{1+}^{\#1}\dagger^{\alpha\beta}$	$\frac{i\,\sqrt{2}\,k}{t_1+k^2\,t_1}$	$\frac{i\,(2\,k^3\,r_5-k\,t_1)}{(1+k^2)^2\,t_1^2}$	$\frac{-2\,k^4\,r_5+k^2\,t_1}{(1+k^2)^2\,t_1^2}$	0	0	0
$\sigma_{1-}^{\#1}\dagger^\alpha$	0	0	0	$\frac{2\,(t_1+t_3)}{3\,t_1\,t_3+2\,k^2\,r_5\,(t_1+t_3)}$	$-\frac{\sqrt{2}\,(t_1-2\,t_3)}{(1+2\,k^2)\,(3\,t_1\,t_3+2\,k^2\,r_5\,(t_1+t_3))}$	0
$\sigma_{1-}^{\#2}\dagger^\alpha$	0	0	0	$-\frac{\sqrt{2}\,(t_1-2\,t_3)}{(1+2\,k^2)\,(3\,t_1\,t_3+2\,k^2\,r_5\,(t_1+t_3))}$	$\frac{6\,k^2\,r_5+t_1+4\,t_3}{(1+2\,k^2)^2\,(3\,t_1\,t_3+2\,k^2\,r_5\,(t_1+t_3))}$	0
$\tau_{1-}^{\#1}\dagger^\alpha$	0	0	0	0	0	0
$\tau_{1-}^{\#2}\dagger^\alpha$	0	0	0	$\frac{2\,i\,k\,(t_1-2\,t_3)}{(1+2\,k^2)\,(3\,t_1\,t_3+2\,k^2\,r_5\,(t_1+t_3))}$	$-\frac{i\,\sqrt{2}\,k\,(6\,k^2\,r_5+t_1+4\,t_3)}{(1+2\,k^2)^2\,(3\,t_1\,t_3+2\,k^2\,r_5\,(t_1+t_3))}$	0

Quadratic (free) action

$$S == \int\int\int(\frac{1}{6}\,(2\,\omega^\alpha{}_\alpha\,(t_1\,\omega^\theta{}_\theta-2\,t_3\,\omega^\kappa{}_\kappa)+6\,f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{a\beta\chi}\,\sigma_{a\beta\chi}-$$

$$4\,t_1\,\omega^\theta{}_\theta\,\partial_{f^\alpha}{}^\alpha+8\,t_3\,\omega^\kappa{}_\kappa\,\partial_{f^\alpha}{}^\alpha+4\,t_1\,\omega^\theta{}_\theta\,\partial_{f^\alpha}{}^\alpha-$$

$$8\,t_3\,\omega^\kappa{}_\kappa\,\partial_{f^\alpha}{}^\alpha-2\,t_1\,\partial_{f^\theta}{}^\theta\partial_{f^\alpha}{}^\alpha+4\,t_3\,\partial_{f^\kappa}{}^\kappa\partial_{f^\alpha}{}^\alpha-$$

$$2\,t_1\,\partial_{f^\alpha}{}^\alpha\partial_{f^\theta}{}^\theta+4\,t_1\,\partial_{f^\alpha}{}^\alpha\partial_{f^\theta}{}^\theta-6\,t_1\,\partial_{f^\alpha}{}^\alpha\partial_{f^\theta}{}^\theta-$$

$$3\,t_1\,\partial_{f^\theta}{}^\theta\partial_{f^\alpha}{}^\alpha+3\,t_1\,\partial_{f^\alpha}{}^\alpha\partial_{f^\theta}{}^\theta+3\,t_1\,\partial_{f^\alpha}{}^\alpha\partial_{f^\theta}{}^\theta-$$

$$3\,t_1\,\partial_{f^\alpha}{}^\alpha\partial_{f^\theta}{}^\theta+6\,t_1\,\omega_{a\theta 1}\,(\omega^{a\theta}+2\,\partial^\theta f^a)+$$

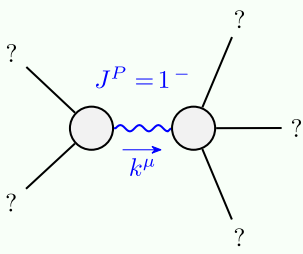
$$6\,r_5\,\partial_{\omega^\kappa{}_\kappa}\,\partial^\theta\omega^\alpha{}_\alpha-6\,r_5\,\partial_\theta\omega^\kappa{}_\kappa\,\partial^\theta\omega^\alpha{}_\alpha+$$

$$4\,t_3\,\partial_{f^\alpha}{}^\alpha\partial_{f^\kappa}{}^\kappa-8\,t_3\,\partial_{f^\alpha}{}^\alpha\partial_{f^\kappa}{}^\kappa-6\,r_5\,\partial_\alpha\omega^{a\theta}\,\partial_\kappa\omega^\kappa{}_\theta+$$

$$12\,r_5\,\partial^\theta\omega^\alpha{}_\alpha\,\partial_\kappa\omega^\kappa{}_\theta+6\,r_5\,\partial_\alpha\omega^{a\theta}\,\partial_\kappa\omega^\kappa{}_\theta-$$

$$12\,r_5\,\partial^\theta\omega^\alpha{}_\alpha\,\partial_\kappa\omega^\kappa{}_\theta)[t,\,x,\,y,\,z]dzdydxdt$$

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{6\,t_1\,t_3\,(t_1+t_3)-3\,r_5\,(t_1^2+2\,t_3^2)}{2\,r_5\,(t_1+t_3)\,(-3\,t_1\,t_3+r_5\,(t_1+t_3))} > 0$
Polarisations:	3
Square mass:	$-\frac{3\,t_1\,t_3}{2\,r_5\,t_1+2\,r_5\,t_3} > 0$
Spin:	1
Parity:	Odd

(No massless particles)

Unitarity conditions

$$r_5 < 0 \ \&\& \ (t_1 < 0 \ \&\& \ 0 < t_3 < -t_1) \ || \ (t_1 > 0 \ \&\& \ (t_3 < -t_1 \ || \ t_3 > 0))$$