

Particle spectrograph

Wave operator and propagator

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

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

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

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

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

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

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

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

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

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

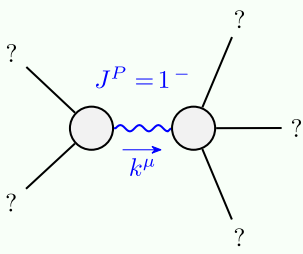
$$6\,r_5\,\partial_{\omega^\kappa{}_\kappa}\,\partial^\theta \omega^\alpha{}_\alpha - 6\,r_5\,\partial_\theta \omega^\kappa{}_\kappa\,\partial^\theta \omega^\alpha{}_\alpha +$$

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

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

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

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

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