Particle spectrograph

Wave operator and propagator
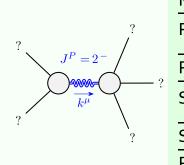
	$\sigma^{\#1}_{1^+\alpha\beta}$	$\sigma^{\#2}_{1^+\alpha\beta}$	$\tau^{\#1}_{1^+\alpha\beta}$	$\sigma^{\#1}_{1^-\alpha}$	$\sigma^{\#2}_{1^-\alpha}$	$\tau^{\#1}_{1^-\alpha}$	$\tau^{\#2}_{1^-\alpha}$
$\sigma^{\#1}_{1^+}\dagger^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	0	0	0	0
$\sigma^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$\frac{-2k^2(2r_1+r_5)+t_1}{(1+k^2)^2 t_1^2}$	$\frac{-2ik^3(2r_1+r_5)+ikt_1}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\tau^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$\frac{i(2k^3(2r_1+r_5)-kt_1)}{(1+k^2)^2 t_1^2}$	$\frac{-2k^4(2r_1+r_5)+k^2 t_1}{(1+k^2)^2 t_1^2}$	0	0	0	0
$\sigma^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{2(t_1+t_3)}{3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3)}$	$-\frac{\sqrt{2}(t_1-2t_3)}{(1+2k^2)(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$	0	$-\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$
$\sigma^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{\sqrt{2}(t_1-2t_3)}{(1+2k^2)(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$	$\frac{6k^2(r_1+r_5)+t_1+4t_3}{(1+2k^2)^2(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$	0	$\frac{i\sqrt{2}\,k(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)^2(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$
$\tau^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$	$-\frac{i\sqrt{2}\,k(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)^2(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$	0	$\frac{2k^2(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)^2(3t_1 t_3+2k^2(r_1+r_5)(t_1+t_3))}$

	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}\dagger$	t_3	$-i\sqrt{2}\,k t_3$	0	0
$f^{\#1}_{0^+}\dagger$	$i\sqrt{2}\,k t_3$	$2k^2 t_3$	0	0
$f^{\#2}_{0^+}\dagger$	0	0	0	0
$\omega^{\#1}_{0^-}\dagger$	0	0	0	$-t_1$

	$\omega^{\#1}_{2^+\alpha\beta}$	$f^{\#1}_{2^+\alpha\beta}$	$\omega^{\#1}_{2^-\alpha\beta\chi}$
$\omega^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega^{\#1}_{2^-}\dagger^{\alpha\beta\chi}$	0	0	$k^2 r_1+\frac{t_1}{2}$

	$\omega^{\#1}_{1^+\alpha\beta}$	$\omega^{\#2}_{1^+\alpha\beta}$	$f^{\#1}_{1^+\alpha\beta}$	$\omega^{\#1}_{1^-\alpha}$	$\omega^{\#2}_{1^-\alpha}$	$f^{\#1}_{1^-\alpha}$	$f^{\#2}_{1^-\alpha}$
$\omega^{\#1}_{1^+}\dagger^{\alpha\beta}$	$k^2(2r_1+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega^{\#2}_{1^+}\dagger^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f^{\#1}_{1^+}\dagger^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{1}{6}(6k^2(r_1+r_5)+t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$\frac{1}{3}ik(t_1-2t_3)$
$\omega^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}\,k(t_1+t_3)$
$f^{\#1}_{1^-}\dagger^{\alpha}$	0	0	0	0	0	0	0
$f^{\#2}_{1^-}\dagger^{\alpha}$	0	0	0	$-\frac{1}{3}ik(t_1-2t_3)$	$-\frac{1}{3}i\sqrt{2}\,k(t_1+t_3)$	0	$\frac{2}{3}k^2(t_1+t_3)$

	$\sigma^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\tau^{\#1}_{2^+}\dagger^{\alpha\beta}$	$\sigma^{\#1}_{2^-}\dagger^{\alpha\beta\chi}$
$\sigma^{\#1}_{2^+\alpha\beta}$	0	0	$\frac{2}{2k^2 r_1+t_1}$
$\tau^{\#1}_{2^+\alpha\beta}$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$-\frac{4k^2}{(1+2k^2)^2 t_1}$	0
$\sigma^{\#2}_{2^+\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0

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

Source constraints

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

Quadratic (free) action

$$S == \iiiint\left(\frac{1}{6}\left(2\omega^{\alpha I}{}_\alpha(t_1\omega_I{}^\theta{}_\theta-2t_3\omega_I{}^\kappa{}_\kappa)+6f^{\alpha\beta}\tau_{\alpha\beta}+6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}-\right.\right.$$
$$4t_1\omega_\alpha{}^\theta{}_\theta\partial_I f^{\alpha I}+8t_3\omega_\alpha{}^\kappa{}_\kappa\partial_I f^{\alpha I}+4t_1\omega_I{}^\theta{}_\theta\partial^I f^\alpha{}_\alpha-$$
$$8t_3\omega_I{}^\kappa{}_\kappa\partial^I f^\alpha{}_\alpha-2t_1\partial_I f^\theta{}_\theta\partial^I f^\alpha{}_\alpha+4t_3\partial_I f^\kappa{}_\kappa\partial^I f^\alpha{}_\alpha-$$
$$2t_1\partial_I f^{\alpha I}\partial_\alpha f_\theta{}^\theta+4t_1\partial^I f^\alpha{}_\alpha\partial_\theta f_I{}^\theta-6t_1\partial_\alpha f_{I\theta}\partial^\theta f^{\alpha I}-$$
$$3t_1\partial_\alpha f_{\theta I}\partial^\theta f^{\alpha I}+3t_1\partial_I f_{\alpha\theta}\partial^\theta f^{\alpha I}+3t_1\partial_\theta f_{\alpha I}\partial^\theta f^{\alpha I}+$$
$$3t_1\partial_\theta f_{I\alpha}\partial^\theta f^{\alpha I}+6t_1\omega_{\alpha\theta I}(\omega^{\alpha I\theta}+2\partial^\theta f^{\alpha I})-$$
$$8r_1\partial_\beta\omega_{\alpha I\theta}\partial^\theta\omega^{\alpha\beta I}+4r_1\partial_\beta\omega_{\alpha\theta\theta}\partial^\theta\omega^{\alpha\beta I}-$$
$$16r_1\partial_I\omega_{I\theta\alpha}\partial^\theta\omega^{\alpha\beta I}-4r_1\partial_I\omega_{\alpha\beta\theta}\partial^\theta\omega^{\alpha\beta I}+$$
$$4r_1\partial_\theta\omega_{\alpha\beta I}\partial^\theta\omega^{\alpha\beta I}+4r_1\partial_\theta\omega_{\alpha I\beta}\partial^\theta\omega^{\alpha\beta I}+$$
$$6r_5\partial_I\omega_\theta{}^\kappa{}_\kappa\partial^\theta\omega^{\alpha I}{}_\alpha-6r_5\partial_\theta\omega_I{}^\kappa{}_\kappa\partial^\theta\omega^{\alpha I}{}_\alpha+$$
$$4t_3\partial_I f^{\alpha I}\partial_\kappa f_\alpha{}^\kappa-8t_3\partial^I f^\alpha{}_\alpha\partial_\kappa f_I{}^\kappa-6r_5\partial_\alpha\omega^{\alpha I\theta}\partial_\kappa\omega_{I\theta}{}^\kappa+$$
$$12r_5\partial^\theta\omega^{\alpha I}{}_\alpha\partial_\kappa\omega_{I\theta}{}^\kappa+6r_5\partial_\alpha\omega^{\alpha I\theta}\partial_\kappa\omega_{\theta I}{}^\kappa-$$
$$\left.\left.12r_5\partial^\theta\omega^{\alpha I}{}_\alpha\partial_\kappa\omega_{\theta}{}^\kappa{}_I\right)\right)[t,x,y,z]\,dz\,dy\,dx\,dt$$

Massive and massless spectra

Massive particle ($J^P=1^-$, k^μ)

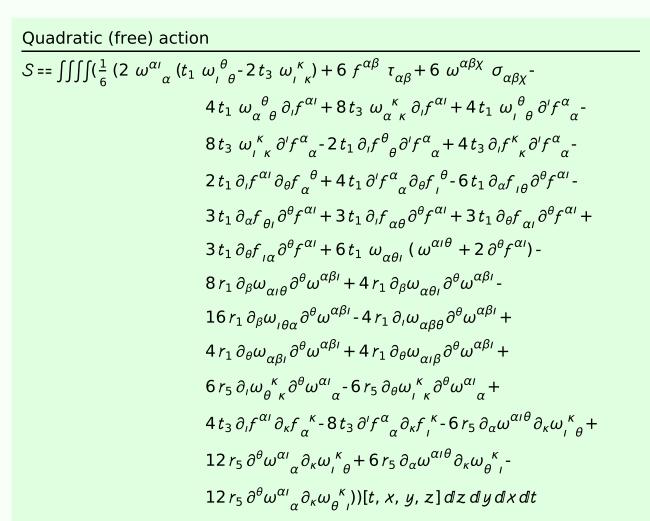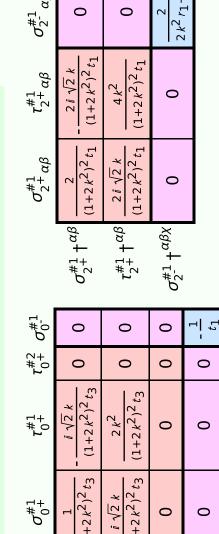| Massive particle	
Pole residue:	$-\frac{3(-2t_1 t_3(t_1+t_3)+r_1(t_1^2+2t_3^2)+r_5(t_1^2+2t_3^2))}{2(r_1+r_5)(t_1+t_3)(-3t_1 t_3+r_1(t_1+t_3)+r_5(t_1+t_3))}>0$
Polarisations:	3
Square mass:	$-\frac{3t_1 t_3}{2(r_1+r_5)(t_1+t_3)}>0$
Spin:	1
Parity:	Odd

Massive particle ($J^P=2^-$, k^μ)

Massive particle	
Pole residue:	$-\frac{1}{r_1}>0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1}>0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_1<0 \,\&\&\, r_5<-r_1 \,\&\&\, t_1>0 \,\&\&\, t_3<-t_1 \,||\, t_3>0$