Particle spectrograph

Wave operator and propagator

	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{1}{6}(6k^2 r_5 + t_1 + 4t_2)$	$-\frac{t_1-2t_2}{3\sqrt2}$	$-\frac{ik(t_1-2t_2)}{3\sqrt2}$	0	0	0	0
$\omega_{1^+}^{\#2}\dagger^{\alpha\beta}$	$-\frac{t_1-2t_2}{3\sqrt2}$	$\frac{t_1+t_2}{3}$	$\frac13 ik(t_1+t_2)$	0	0	0	0
$f_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{ik(t_1-2t_2)}{3\sqrt2}$	$-\frac13 ik(t_1+t_2)$	$\frac13 k^2(t_1+t_2)$	0	0	0	0
$\omega_{1^-}^{\#1}\dagger^{\alpha}$	0	0	0	$k^2 r_5 - \frac{t_1}{2}$	$\frac{t_1}{\sqrt2}$	0	ikt_1
$\omega_{1^-}^{\#2}\dagger^{\alpha}$	0	0	0	$\frac{t_1}{\sqrt2}$			
$f_{1^-}^{\#1}\dagger^{\alpha}$	0	0	0				
$f_{1^-}^{\#2}\dagger^{\alpha}$	0	0	0	$-ikt_1$			

	$\sigma_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1^+}^{\#2}\dagger^{\alpha\beta}$	$\tau_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1^-}^{\#1}\dagger^{\alpha}$	$\sigma_{1^-}^{\#2}\dagger^{\alpha}$	$\tau_{1^-}^{\#1}\dagger^{\alpha}$	$\tau_{1^-}^{\#2}\dagger^{\alpha}$
$\tau_{1^-}^{\#2}{}_{\alpha}$	0	0	0	$\frac{2ik}{t_1+2k^2 t_1}$	$-\frac{i\sqrt2 k(2k^2 r_5 - t_1)}{(t_1+2k^2 t_1)^2}$	0	$-\frac{4k^4 r_5 + 2k^2 t_1}{(t_1+2k^2 t_1)^2}$
$\tau_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#2}{}_{\alpha}$	0	0	0	$\frac{\sqrt2}{t_1+2k^2 t_1}$	$-\frac{2k^2+t_1}{(t_1+2k^2 t_1)^2}$	0	$\frac{i\sqrt2 k(2k^2 r_5 - t_1)}{(t_1+2k^2 t_1)^2}$
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	$\frac{\sqrt2}{t_1+2k^2 t_1}$	0	$-\frac{2ik}{t_1+2k^2 t_1}$
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{i\sqrt2 k(t_1-2t_2)}{(1+k^2)(3t_1 t_2+2k^2 r_5(t_1+t_2))}$	$\frac{ik(6k^2 r_5+t_1+4t_2)}{(1+k^2)^2(3t_1 t_2+2k^2 r_5(t_1+t_2))}$	$\frac{k^2(6k^2 r_5+t_1+4t_2)}{(1+k^2)^2(3t_1 t_2+2k^2 r_5(t_1+t_2))}$	0	0	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\frac{\sqrt2(t_1-2t_2)}{3t_1 t_2+2k^2 r_5(t_1+t_2)}$	$\frac{6k^2 r_5+t_1+4t_2}{(1+k^2)(3t_1 t_2+2k^2 r_5(t_1+t_2))}$	$-\frac{ik(6k^2 r_5+t_1+4t_2)}{(1+k^2)^2(3t_1 t_2+2k^2 r_5(t_1+t_2))}$	0	0	0	0
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{2(t_1+t_2)}{3t_1 t_2+2k^2 r_5(t_1+t_2)}$	$\frac{\sqrt2(t_1-2t_2)}{3t_1 t_2+2k^2 r_5(t_1+t_2)}$	$-\frac{i\sqrt2 k(t_1-2t_2)}{(1+k^2)(3t_1 t_2+2k^2 r_5(t_1+t_2))}$	0	0	0	0

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt2}$	0
$f_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{ikt_1}{\sqrt2}$	$k^2 t_1$	0
$\omega_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	$\frac{t_1}{2}$

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\dagger$	$-\frac{1}{(1+2k^2)^2 t_1}$	$\frac{i\sqrt2 k}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0^+}^{\#1}\dagger$	$-\frac{i\sqrt2 k}{(1+2k^2)^2 t_1}$	$-\frac{2k^2}{(1+2k^2)^2 t_1}$	0	0
$\tau_{0^+}^{\#2}\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\dagger$	0	0	0	$\frac{1}{k^2 r_2 + t_2}$

	$\sigma_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\tau_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$
$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$	0	0	$\frac{2}{t_1}$
$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$-\frac{2i\sqrt2 k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0
$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$\frac{2i\sqrt2 k}{(1+2k^2)^2 t_1}$	0

|	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\dagger$	$-t_1$	$i\sqrt2 kt_1$	0	0
$f_{0^+}^{\#1}\dagger$	$-i\sqrt2 kt_1$	$-2k^2 t_1$	0	0
$f_{0^+}^{\#2}\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\dagger$	0	0	0	$k^2 r_2 + t_2$

Quadratic (free) action

$S ==$
$$\iiint\big[\tfrac16\big(6t_1\,\omega_{\alpha}{}^{\theta}{}_{,\theta}\,\omega_{\iota,\theta}{}^{\theta} + 6 f^{\alpha\beta}\tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi} - 12 t_1\,\omega_{\alpha}{}^{\theta}{}_{\theta}\partial_\iota f^{\alpha\iota} + 12 t_1$$
$$\omega_{\iota,\theta}{}^{\theta}\partial^\theta f^{\alpha}{}_\alpha - 6 t_1 \partial_\iota f^{\theta}{}_\theta \partial^\iota f^{\alpha}{}_\alpha - 6 t_1 \partial_\iota f^{\alpha\iota}\partial^\theta f^{\alpha}{}_\alpha + 12 t_1 \partial^\iota f^{\alpha}{}_\alpha \partial_\theta f^{\theta}{}_\iota +$$
$$4 t_1 \omega_{\iota\theta\alpha}\partial^\theta f^{\alpha\iota} + 4 t_2 \omega_{\iota\theta\alpha}\partial^\theta f^{\alpha\iota} - 4 t_1 \partial_\alpha f_{\iota\theta}\partial^\theta f^{\alpha\iota} + 2 t_2 \partial_\alpha f_{\iota\theta}\partial^\theta f^{\alpha\iota} -$$
$$4 t_1 \partial_\alpha f_{\theta\iota}\partial^\theta f^{\alpha\iota} - t_2 \partial_\alpha f_{\theta\iota}\partial^\theta f^{\alpha\iota} + 2 t_1 \partial_\iota f_{\alpha\theta}\partial^\theta f^{\alpha\iota} + 2 t_1 \partial_\theta f_{\iota\alpha}\partial^\theta f^{\alpha\iota} - t_2 \partial_\theta f_{\iota\alpha}\partial^\theta f^{\alpha\iota} +$$
$$2(t_1+t_2)\,\omega_{\alpha\iota\theta}\big(\omega^{\alpha\iota\theta}+2\partial^\theta f^{\alpha\iota}\big) + 2\,\omega_{\alpha\iota\theta}\big((t_1-2t_2)\omega^{\alpha\iota\theta}+2(2t_1-t_2)\partial^\theta f^{\alpha\iota}\big) +$$
$$8 r_2 \partial_\beta\omega_{\alpha\iota\theta}\partial^\theta\omega^{\alpha\beta\iota} - 4 r_2 \partial_\theta\omega_{\alpha\beta\iota}\partial^\theta\omega^{\alpha\beta\iota} + 4 r_2 \partial_\beta\omega_{\iota\theta\alpha}\partial^\theta\omega^{\alpha\beta\iota} - 2 r_2 \partial_\iota\omega_{\alpha\beta\theta}$$
$$\partial^\theta\omega^{\alpha\beta\iota} + 2 r_2 \partial_\theta\omega_{\alpha\beta\iota}\partial^\theta\omega^{\alpha\beta\iota} - 4 r_2 \partial_\theta\omega_{\alpha\iota\beta}\partial^\theta\omega^{\alpha\beta\iota} + 6 r_5 \partial_\iota\omega_{\kappa}{}^{\kappa}\partial^\theta\omega^{\alpha\iota}{}_\theta +$$
$$6 r_5 \partial_\theta\omega_{\iota}{}^{\kappa}{}_{\kappa}\partial^\theta\omega^{\alpha\iota}{}_\theta - 6 r_5 \partial_\alpha\omega^{\alpha\iota\theta}\partial_\kappa\omega_{\theta\iota}{}^{\kappa} + 12 r_5 \partial^\theta\omega^{\alpha\iota}{}_\alpha\partial_\kappa\omega_{\theta\iota}{}^{\kappa} +$$
$$6 r_5 \partial_\alpha\omega^{\alpha\iota\theta}\partial_\kappa\omega_{\theta}{}^{\kappa}{}_\iota - 12 r_5 \partial^\theta\omega^{\alpha\iota}{}_\alpha\partial_\kappa\omega_{\theta}{}^{\kappa}{}_\iota\big)\big][t,x,y,z]\,dz\,dy\,dx\,dt$$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2}==0$	1
$\tau_{0^+}^{\#1} - 2ik\,\sigma_{0^+}^{\#1}==0$	1
$\tau_{1^-}^{\#2\,\alpha} + 2ik\,\sigma_{1^-}^{\#2\,\alpha}==0$	3
$\tau_{1^-}^{\#1\,\alpha}==0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + ik\,\sigma_{1^+}^{\#2\,\alpha\beta}==0$	3
$\tau_{2^+}^{\#1\,\alpha\beta} - 2ik\,\sigma_{2^+}^{\#1\,\alpha\beta}==0$	5
Total constraints:	16

Massive and massless spectra
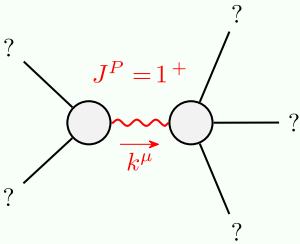
Massive particle ($J^P = 1^+$)

Pole residue:	$\frac{-3t_1 t_2(t_1+t_2)+3r_5(t_1^2+2t_2^2)}{r_5(t_1+t_2)(-3t_1 t_2+2r_5(t_1+t_2))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1 t_2}{2r_5 t_1 + 2r_5 t_2} > 0$
Spin:	1
Parity:	Even
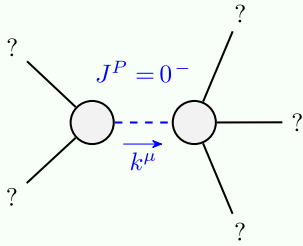
Massive particle ($J^P = 0^-$)

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

$r_2 < 0\ \&\&\ r_5 > 0\ \&\&\ t_1 < 0\ \&\&\ t_2 > -t_1$