Particle spectrograph

Wave operator and propagator

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

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	t_3	$-i\,\sqrt{2}\,k\,t_3$	0	0
$f_{0^+}^{\#1}\,\dagger$	$i\,\sqrt{2}\,k\,t_3$	$2\,k^2\,t_3$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	$-t_1$

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

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

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

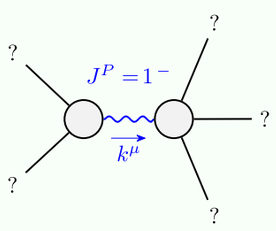
	$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
$\sigma_{1^+}^{\#1}\,\dagger^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1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

Quadratic (free) action

$$S_F == \iiint\left(\tfrac{1}{6}\,(-2\,(t_1 - 2\,t_3)\;\omega_{\iota}^{\alpha\prime\prime}\;\omega_{\kappa\alpha}^{\kappa} - 6\,t_1\;\omega_{\iota}^{\kappa\lambda}\;\omega_{\kappa\lambda}^{\prime} + 6\,f^{\alpha\beta}\;\tau_{\alpha\beta} + 6\;\omega^{\alpha\beta\chi}\;\sigma_{\alpha\beta\chi} - \right.$$
$$6\,r_5\,\partial_\iota\omega^{\kappa\lambda}{}_\kappa\,\partial^\prime\omega_\lambda{}^\alpha{}_\alpha - 6\,r_5\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial_\kappa\omega^{\theta\kappa\lambda} + 6\,r_5\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda} -$$
$$6\,r_5\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial_\kappa\omega^{\kappa\lambda\theta} + 12\,r_5\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\kappa\lambda\theta} - 3\,t_1\,\partial^\alpha f_{\theta\kappa}\,\partial^\kappa f_\alpha{}^\theta -$$
$$3\,t_1\,\partial^\alpha f_{\kappa\theta}\,\partial^\kappa f_\alpha{}^\theta - 3\,t_1\,\partial^\alpha f^\lambda{}_\kappa\,\partial^\kappa f_{\alpha\lambda} + 2\,t_1\;\omega_{\kappa\alpha}{}^\alpha\,\partial^\kappa f^\prime{}_\iota - 4\,t_3\;\omega_{\kappa\alpha}{}^\alpha\,\partial^\kappa f^\prime{}_\iota +$$
$$2\,t_1\;\omega_{\kappa\lambda}{}^\lambda\,\partial^\kappa f^\prime{}_\iota - 4\,t_3\;\omega_{\kappa\lambda}{}^\lambda\,\partial^\kappa f^\prime{}_\iota + 4\,t_1\,\partial^\alpha f_{\kappa\alpha}\,\partial^\kappa f^\prime{}_\iota - 8\,t_3\,\partial^\alpha f_{\kappa\alpha}\,\partial^\kappa f^\prime{}_\iota -$$
$$2\,t_1\,\partial_\kappa f^\lambda{}_\iota\,\partial^\kappa f^\prime{}_\lambda + 4\,t_3\,\partial_\kappa f^\lambda{}_\iota\,\partial^\kappa f^\prime{}_\lambda + 12\,t_1\;\omega_{\iota\kappa\theta}\,\partial^\kappa f^{\iota\theta} - 2\,t_1\;\omega_{\iota\alpha}{}^\alpha\,\partial^\kappa f^\prime{}_\kappa +$$
$$4\,t_3\;\omega_{\iota\alpha}{}^\alpha\,\partial^\kappa f^\prime{}_\kappa - 2\,t_1\;\omega_{\iota\lambda}{}^\lambda\,\partial^\kappa f^\prime{}_\kappa + 4\,t_3\;\omega_{\iota\lambda}{}^\lambda\,\partial^\kappa f^\prime{}_\kappa + 3\,t_1\,\partial^\alpha f^\lambda{}_\kappa\,\partial^\kappa f_{\lambda\alpha} +$$
$$3\,t_1\,\partial_\kappa f^\lambda{}_\theta\,\partial^\kappa f_\lambda{}^\theta + 3\,t_1\,\partial_\kappa f^\lambda{}_\theta\,\partial^\kappa f_\lambda{}^\theta - 2\,t_1\,\partial^\alpha f^\lambda{}_\alpha\,\partial^\kappa f_{\lambda\kappa} + 4\,t_3\,\partial^\alpha f^\lambda{}_\alpha\,\partial^\kappa f_{\lambda\kappa} +$$
$$\left. 6\,r_5\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa - 6\,r_5\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa\right)[t,\,x,\,y,\,z]\,d\!\!\!/z\,d\!\!\!/y\,d\!\!\!/x\,d\!\!\!/t$$

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

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

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