Particle spectrograph

Wave operator and propagator

	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$
$\tau_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	$\frac{i\sqrt{2}\,k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$
$\tau_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0	0	$\frac{ik(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{6k^2(2r_1+r_5)+t_1+4t_2}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	0	0	0	$\frac{2ik}{t_1+2k^2t_1}$	0	$\frac{k^2(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$-\frac{ik(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	0	$\frac{2ik}{t_1+2k^2t_1}$	0	0	0	0
$\sigma_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{2ik}{t_1+2k^2t_1}$	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	0	0	0	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$-\frac{2ik}{t_1+2k^2t_1}$	$\frac{-2k^2(r_1+r_5)+t_1}{(t_1+2k^2t_1)^2}$	0	0	0	0	0
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{2(t_1+t_2)}{3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2)}$	$\frac{\sqrt{2}\,(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{ik(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0	0	0
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{\sqrt{2}\,k(t_1-2t_2)}{3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2)}$	$\frac{6k^2(2r_1+r_5)+t_1+4t_2}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$-\frac{ik(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\frac{ik\sqrt{2}\,(t_1-2t_2)}{3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2)}$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$\tau_{1^-}^{\#1}{}^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2}{}^{\alpha}$	0	0	0	0	0	0	0

	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0
$\omega_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0
$f_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0
$f_{1^-}^{\#2}{}_{\alpha}$	$-i\,k\,t_1$	0	0	0

	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$
$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{1}{6}(6k^2(2r_1+r_5)+t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{ik(t_1-2t_2)}{3\sqrt{2}}$
$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}ik(t_1+t_2)$
$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}ik(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$
$\omega_{1^-}^{\#1}{}^{\alpha}$	0	0	0
$\omega_{1^-}^{\#2}{}^{\alpha}$	0	0	0
$f_{1^-}^{\#1}{}^{\alpha}$	0	0	0
$f_{1^-}^{\#2}{}^{\alpha}$	0	0	0

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

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}{}^{\dagger}$	$-t_1$	$i\sqrt{2}\,kt_1$	0	0
$f_{0^+}^{\#1}{}^{\dagger}$	$-i\sqrt{2}\,kt_1$	$-2k^2t_1$	0	0
$f_{0^+}^{\#2}{}^{\dagger}$	0	0	0	0
$\omega_{0^-}^{\#1}{}^{\dagger}$	0	0	0	t_2

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

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

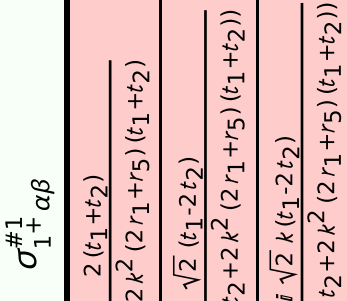
Source constraints/gauge generators

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

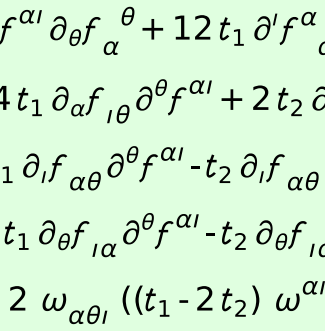
Quadratic (free) action

$$
\begin{aligned}
S == \iiiint \Big(&\tfrac{1}{6}(6t_1\,\omega^{\alpha\prime}{}_{\alpha}\,\omega_{\prime}{}^{\theta}{}_{\theta}+6\,f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}-12t_1\,\omega_{\alpha}{}^{\theta}{}_{\theta}\,\partial_{\prime}f^{\alpha\prime}+12t_1\\
&\omega_{\prime}{}^{\theta}{}_{\theta}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-6t_1\,\partial_{\prime}f^{\theta}{}_{\theta}\partial^{\prime}f^{\alpha}{}_{\alpha}-6t_1\,\partial_{\prime}f^{\alpha\prime}\partial_{\theta}f_{\alpha}{}^{\theta}+12t_1\,\partial^{\prime}f^{\alpha}{}_{\alpha}\partial_{\theta}f_{\prime}{}^{\theta}+\\
&4t_1\,\omega_{\prime\theta\alpha}\,\partial^{\theta}f^{\alpha\prime}+4t_2\,\omega_{\prime\theta\alpha}\,\partial^{\theta}f^{\alpha\prime}-4t_1\,\partial_{\alpha}f_{\prime\theta}\partial^{\theta}f^{\alpha\prime}+2t_2\,\partial_{\alpha}f_{\prime\theta}\partial^{\theta}f^{\alpha\prime}-\\
&4t_1\,\partial_{\alpha}f_{\theta\prime}\partial^{\theta}f^{\alpha\prime}-t_2\,\partial_{\alpha}f_{\theta\prime}\partial^{\theta}f^{\alpha\prime}+2t_1\,\partial_{\prime}f_{\alpha\theta}\partial^{\theta}f^{\alpha\prime}-t_2\,\partial_{\prime}f_{\alpha\theta}\partial^{\theta}f^{\alpha\prime}+\\
&4t_1\,\partial_{\theta}f_{\alpha\prime}\partial^{\theta}f^{\alpha\prime}+t_2\,\partial_{\theta}f_{\alpha\prime}\partial^{\theta}f^{\alpha\prime}+2t_1\,\partial_{\theta}f_{\prime\alpha}\partial^{\theta}f^{\alpha\prime}-t_2\,\partial_{\theta}f_{\prime\alpha}\partial^{\theta}f^{\alpha\prime}+\\
&2(t_1+t_2)\,\omega_{\alpha\prime\theta}\,(\omega^{\alpha\prime\theta}+2\,\partial^{\theta}f^{\alpha\prime})+2\,\omega_{\alpha\theta\prime}\,((t_1-2t_2)\,\omega^{\alpha\prime\theta}+2(2t_1-t_2)\,\partial^{\theta}f^{\alpha\prime})-\\
&8r_1\,\partial_{\beta}\omega_{\alpha\prime\theta}\partial^{\theta}\omega^{\alpha\beta\prime}+4r_1\,\partial_{\beta}\omega_{\alpha\theta\prime}\partial^{\theta}\omega^{\alpha\beta\prime}-16r_1\,\partial_{\beta}\omega_{\prime\theta\alpha}\partial^{\theta}\omega^{\alpha\beta\prime}-\\
&4r_1\,\partial_{\prime}\omega_{\alpha\beta\theta}\partial^{\theta}\omega^{\alpha\beta\prime}+4r_1\,\partial_{\theta}\omega_{\alpha\beta\prime}\partial^{\theta}\omega^{\alpha\beta\prime}+4r_1\,\partial_{\theta}\omega_{\alpha\prime\beta}\partial^{\theta}\omega^{\alpha\beta\prime}+6r_5\,\partial_{\prime}\omega_{\theta}{}^{\kappa}{}_{\kappa}\\
&\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}-6r_5\,\partial_{\theta}\omega_{\prime}{}^{\kappa}{}_{\kappa}\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}-6r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\partial_{\kappa}\omega_{\prime}{}^{\kappa}{}_{\theta}+12r_5\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}\partial_{\kappa}\omega_{\prime}{}^{\kappa}{}_{\theta}+\\
&6r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime}-12r_5\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime})\Big)[t,x,y,z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{-3t_1t_2(t_1+t_2)+6r_1(t_1^2+2t_2^2)+3r_5(t_1^2+2t_2^2)}{(2r_1+r_5)(t_1+t_2)(-3t_1t_2+4r_1(t_1+t_2)+2r_5(t_1+t_2))}>0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_2}{2(2r_1+r_5)(t_1+t_2)}>0$
Spin:	1
Parity:	Even



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

$r_1<0\;\&\&\;r_5>-2r_1\;\&\&\;t_1>0\;\&\&\;-t_1<t_2<0$