Particle spectrograph

Wave operator and propagator

	$\sigma_{1^-}^{\#2\ \alpha}$	$\tau_{1^-}^{\#1\ \alpha}$	$\tau_{1^-}^{\#2\ \alpha}$
$\sigma_{1^+}^{\#1\ \alpha\beta}$	$\frac{\sqrt{2}\ (t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2r_5(t_1+t_3))}$	0	$-\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2r_5(t_1+t_3))}$
$\sigma_{1^+}^{\#2\ \alpha\beta}$	$\frac{6k^2r_5+t_1+4t_3}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$	0	$\frac{i\sqrt{2}\,k(6k^2r_5+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$
$\tau_{1^+}^{\#1\ \alpha\beta}$	0	0	0
$\sigma_{1^-}^{\#1\ \alpha}$	$\frac{i\sqrt{2}\,k(6k^2r_5+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$	0	$\frac{2k^2(6k^2r_5+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$
$\sigma_{1^-}^{\#2\ \alpha}$	0	0	0
$\tau_{1^-}^{\#1\ \alpha}$	0	0	0
$\tau_{1^-}^{\#2\ \alpha}$	0	0	0

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\dagger$	$\frac{1}{(1+2k^2)^2t_3}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_3}$	0	0
$\tau_{0^+}^{\#1}\dagger$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$	0	0
$\tau_{0^+}^{\#2}\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\dagger$	0	0	0	$\frac{1}{k^2r_2-t_1}$

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

	$\omega_{1^+}^{\#1\ \alpha\beta}$	$\omega_{1^+}^{\#2\ \alpha\beta}$	$f_{1^+}^{\#1\ \alpha\beta}$	$\omega_{1^-}^{\#1\ \alpha}$	$\omega_{1^-}^{\#2\ \alpha}$	$f_{1^-}^{\#1\ \alpha}$	$f_{1^-}^{\#2\ \alpha}$
$\sigma_{1^+}^{\#1\ \alpha\beta}\dagger$	$k^2r_5-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\sigma_{1^+}^{\#2\ \alpha\beta}\dagger$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\tau_{1^+}^{\#1\ \alpha\beta}\dagger$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\sigma_{1^-}^{\#1\ \alpha}\dagger$	0	0	0	$\frac{1}{6}(6k^2r_5+t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$-\frac{1}{3}ik(t_1-2t_3)$
$\sigma_{1^-}^{\#2\ \alpha}\dagger$	0	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$-\frac{1}{3}i\sqrt{2}\,k(t_1+t_3)$
$f_{1^-}^{\#1\ \alpha}\dagger$	0	0	0	0	0	0	$\frac{2}{3}k^2(t_1+t_3)$
$f_{1^-}^{\#2\ \alpha}\dagger$	0	0	0	$-\frac{1}{3}ik(t_1-2t_3)$	$-\frac{1}{3}i\sqrt{2}\,k(t_1+t_3)$	$\frac{2}{3}k^2(t_1+t_3)$	0

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\dagger$	t_3	$-i\sqrt{2}\,kt_3$	0	0
$f_{0^+}^{\#1}\dagger$	$i\sqrt{2}\,kt_3$	$2k^2t_3$	0	0
$f_{0^+}^{\#2}\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\dagger$	0	0	0	$k^2r_2-t_1$

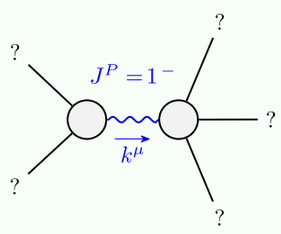
	$\omega_{2^+}^{\#1\ \alpha\beta}$	$f_{2^+}^{\#1\ \alpha\beta}$	$\omega_{2^-}^{\#1\ \alpha\beta\chi}$
$\omega_{2^+}^{\#1\ \alpha\beta}\dagger$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1\ \alpha\beta}\dagger$	$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
$\omega_{2^-}^{\#1\ \alpha\beta\chi}\dagger$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

Source constraints/gauge generators	Multiplicities
SO(3) irreps	
$\tau_{0^+}^{\#2}==0$	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

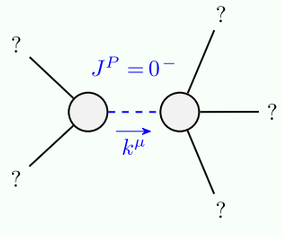
Quadratic (free) action

$$S==\int\int\int\left(\frac{1}{6}(2\,\omega^{\alpha\prime}{}_{\alpha}\,(t_1\,\omega_{\prime}{}^{\theta}{}_{\theta}-2\,t_3\,\omega_{\prime}{}^{\kappa}{}_{\kappa})+6\,f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}-4\,t_1\,\omega_{\alpha}{}^{\theta}{}_{\theta}\,\partial_{\prime}f^{\alpha\prime}+8\,t_3\,\omega_{\alpha}{}^{\kappa}{}_{\kappa}\,\partial_{\prime}f^{\alpha\prime}+4\,t_1\,\omega_{\prime}{}^{\theta}{}_{\theta}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-8\,t_3\,\omega_{\prime}{}^{\kappa}{}_{\kappa}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-2\,t_1\,\partial_{\prime}f^{\theta}{}_{\theta}\,\partial^{\prime}f^{\alpha}{}_{\alpha}+4\,t_3\,\partial_{\prime}f^{\kappa}{}_{\kappa}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-2\,t_1\,\partial_{\prime}f^{\alpha\prime}{}_{\theta}\,\partial_{\theta}f^{\theta}{}_{\alpha}+4\,t_1\,\partial^{\prime}f^{\alpha}{}_{\alpha}\,\partial_{\theta}f^{\theta}{}_{\prime}-6\,t_1\,\partial_{\alpha}f_{\prime\theta}\,\partial^{\theta}f^{\alpha\prime}-3\,t_1\,\partial_{\alpha}f_{\theta\prime}\,\partial^{\theta}f^{\alpha\prime}+3\,t_1\,\partial_{\prime}f_{\alpha\theta}\,\partial^{\theta}f^{\alpha\prime}+3\,t_1\,\partial_{\theta}f_{\alpha\prime}\,\partial^{\theta}f^{\alpha\prime}+6\,t_1\,\partial_{\theta}f_{\prime\alpha}\,\partial^{\theta}f^{\alpha\prime}+6\,t_1\,\omega_{\alpha\theta\prime}\,(\omega^{\alpha\prime\theta}+2\,\partial^{\theta}f^{\alpha\prime})+8\,r_2\,\partial_{\beta}\omega_{\alpha\prime\theta}\,\partial^{\theta}\omega^{\alpha\beta\prime}-4\,r_2\,\partial_{\beta}\omega_{\alpha\theta\prime}\,\partial^{\theta}\omega^{\alpha\beta\prime}-2\,r_2\,\partial_{\prime}\omega_{\alpha\beta\theta}\,\partial^{\theta}\omega^{\alpha\beta\prime}+2\,r_2\,\partial_{\theta}\omega_{\alpha\beta\prime}-4\,r_2\,\partial_{\theta}\omega_{\alpha\prime\beta}\,\partial^{\theta}\omega^{\alpha\beta\prime}+6\,r_5\,\partial_{\prime}\omega_{\theta}{}^{\kappa}\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}-6\,r_5\,\partial_{\theta}\omega_{\prime}{}^{\kappa}\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}+4\,t_3\,\partial_{\prime}f^{\alpha\prime}\,\partial_{\kappa}f_{\alpha}{}^{\kappa}-8\,t_3\,\partial^{\prime}f^{\alpha}{}_{\alpha}\,\partial_{\kappa}f_{\prime}{}^{\kappa}-6\,r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\,\partial_{\kappa}\omega_{\prime}{}^{\kappa}{}_{\theta}+12\,r_5\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}\,\partial_{\kappa}\omega_{\prime}{}^{\kappa}{}_{\theta}+6\,r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\,\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime}-12\,r_5\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}\,\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime})\right)[t,\,x,\,y,\,z]\,dt\,dx\,dy\,dz$$

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{6t_1t_3(t_1+t_3)-3r_5(t_1{}^2+2t_3{}^2)}{2r_5(t_1+t_3)(-3t_1t_3+r_5(t_1+t_3))}>0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_3}{2r_5t_1+2r_5t_3}>0$
Spin:	1
Parity:	Odd



Massive particle	
Pole residue:	$-\frac{1}{r_2}>0$
Polarisations:	1
Square mass:	$\frac{t_1}{r_2}>0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_2<0\ \&\&\ r_5<0\ \&\&\ t_1<0\ \&\&\ 0<t_3<-t_1$