Particle spectrograph

Wave operator and propagator

	$\sigma_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\sigma_{1^+}^{\#2}{}^{\dagger\alpha\beta}$	$\tau_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\sigma_{1^-}^{\#1}{}^{\dagger\alpha}$	$\sigma_{1^-}^{\#2}{}^{\dagger\alpha}$	$\tau_{1^-}^{\#1}{}^{\dagger\alpha}$	$\tau_{1^-}^{\#2}{}^{\dagger\alpha}$
$\tau_{1^-}^{\#2}{}_{\alpha}$	0	0	0	$\frac{2 i k}{t_1+2k^2 t_1}$	$-\frac{i\sqrt{2}\,k\,(2k^2(r_1+r_5)-t_1)}{(t_1+2k^2t_1)^2}$	0	$-\frac{4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$
$\tau_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#2}{}_{\alpha}$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$-\frac{2k^2(r_1+r_5)+t_1}{(t_1+2k^2t_1)^2}$	0	$\frac{i\sqrt{2}\,k\,(2k^2(r_1+r_5)-t_1)}{(t_1+2k^2t_1)^2}$
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	0	$-\frac{2 i k}{t_1+2k^2t_1}$
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2t_1}$	$-\frac{2ik^3(2r_1+r_5)+ikt_1}{(1+k^2)^2t_1^2}$	$-\frac{2k^4(2r_1+r_5)+k^2t_1}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$-\frac{2k^2(2r_1+r_5)+t_1}{(1+k^2)^2t_1^2}$	$\frac{i(2k^3(2r_1+r_5)-kt_1)}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{i\sqrt{2}\,k}{t_1+k^2t_1}$	0	0	0	0

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

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

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

Quadratic (free) action

$$S == \iiiint\Big(f^{\alpha\beta}\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}+\tfrac{1}{2}t_1\big(2\,\omega^{\alpha\iota}{}_{\alpha}\,\omega_{\iota}{}^{\theta}{}_{\theta}-4\,\omega_{\alpha}{}^{\theta}{}_{\theta}\,\partial_{\iota}f^{\alpha\iota}+4\,\omega_{\iota}{}^{\theta}{}_{\theta}\,\partial^{\iota}f^{\alpha}{}_{\alpha}-2\,\partial_{\iota}f^{\theta}{}_{\theta}\,\partial^{\iota}f^{\alpha}{}_{\alpha}-2\,\partial_{\iota}f^{\alpha\iota}\,\partial_{\theta}f_{\alpha}{}^{\theta}+4\,\partial^{\iota}f^{\alpha}{}_{\alpha}\,\partial_{\theta}f_{\iota}{}^{\theta}-2\,\partial_{\alpha}f_{\iota\theta}\,\partial^{\theta}f^{\alpha\iota}-\partial_{\alpha}f_{\theta\iota}\,\partial^{\theta}f^{\alpha\iota}+\partial_{\iota}f_{\alpha\theta}\,\partial^{\theta}f^{\alpha\iota}+\partial_{\theta}f_{\alpha\iota}\,\partial^{\theta}f^{\alpha\iota}+\partial_{\theta}f_{\iota\alpha}\,\partial^{\theta}f^{\alpha\iota}+2\,\omega_{\alpha\theta\iota}\,(\omega^{\alpha\iota\theta}+2\,\partial^{\theta}f^{\alpha\iota})\big)-\tfrac{2}{3}r_1\,(2\,\partial_{\beta}\omega_{\alpha\iota\theta}-\partial_{\beta}\omega_{\alpha\theta\iota}+4\,\partial_{\beta}\omega_{\iota\theta\alpha}+\partial_{\iota}\omega_{\alpha\beta\theta}-\partial_{\theta}\omega_{\alpha\beta\iota}-\partial_{\theta}\omega_{\alpha\iota\beta})\,\partial^{\theta}\omega^{\alpha\beta\iota}+r_5\,(\partial_{\iota}\omega_{\theta}{}^{\kappa}{}_{\kappa}\,\partial^{\theta}\omega^{\alpha\iota}{}_{\alpha}-\partial_{\theta}\omega_{\iota}{}^{\kappa}{}_{\kappa}\,\partial^{\theta}\omega^{\alpha\iota}{}_{\alpha}-(\partial_{\alpha}\omega^{\alpha\iota\theta}-2\,\partial^{\theta}\omega^{\alpha\iota}{}_{\alpha})\,(\partial_{\kappa}\omega_{\iota}{}^{\kappa}{}_{\theta}-\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\iota}))\Big)[t,x,y,z]\,dz\,dy\,dx\,dt$$

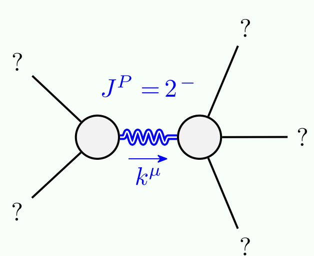
Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} - 2 i k\,\sigma_{0^+}^{\#1} == 0$	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

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

	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$k^2(2r_1+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2}{}^{\dagger\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	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	$k^2(r_1+r_5)-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$i k t_1$
$\omega_{1^-}^{\#2}{}^{\dagger\alpha}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1^-}^{\#1}{}^{\dagger\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2}{}^{\dagger\alpha}$	0	0	0	$-i k t_1$	0	0	0

Massive and massless spectra



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

$r_1 < 0\ \&\&\ t_1 > 0$