Particle spectrograph

Wave operator and propagator

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

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

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

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

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\sigma_{0^-}^{\#1} == 0$	1
$\tau_{0^+}^{\#2} == 0$	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:	17

Quadratic (free) action

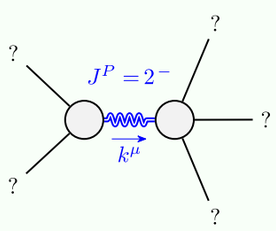
$$S_F == \int\int\int\int\Big(\tfrac{1}{3}\,(-3\,t_1\,\omega_{\iota}^{\alpha\iota}\,\omega_{\kappa\alpha}^{\kappa} - t_1\,\omega_{\iota}^{\kappa\lambda}\,\omega_{\kappa\lambda}^{\prime} + t_1\,\omega_{\kappa\lambda}^{\prime}\,\omega^{\kappa\lambda}{}_{\iota}^{\prime} + 3\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 3\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - 3\,r_5\,\partial_{\iota}\omega^{\kappa\lambda}\,\partial^{\prime}\omega_{\lambda\,\alpha}^{\alpha} - 2\,r_1\,\partial^{\beta}\omega^{\theta\alpha}{}_{\kappa}\,\partial_{\theta}\omega_{\alpha\beta}^{\kappa} - 2\,r_1\,\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\,\partial_{\kappa}\omega^{\theta\alpha\beta} - 3\,r_5\,\partial_{\alpha}\omega_{\lambda\,\theta}^{\alpha}\,\partial_{\kappa}\omega^{\theta\kappa\lambda} + 3\,r_5\,\partial_{\alpha}\omega_{\lambda\,\theta}^{\alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta} + 6\,r_5\,\partial_{\theta}\omega_{\lambda\,\alpha}^{\alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta} - t_1\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\alpha\lambda}^{\prime} + 3\,t_1\,\omega_{\kappa\alpha}^{\alpha}\,\partial^{\kappa}f_{\iota}^{\prime} + 3\,t_1\,\omega_{\kappa\lambda}^{\lambda}\,\partial^{\kappa}f_{\iota}^{\prime} - t_1\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\lambda\alpha}^{\prime} - t_1\,\partial^{\alpha}f^{\lambda}{}_{\iota}\,\partial^{\kappa}f_{\lambda\kappa}^{\prime} + 3\,t_1\,\partial_{\kappa}f^{\lambda}{}_{\lambda}\,\partial^{\kappa}f_{\iota}^{\prime} + t_1\,\omega_{\iota\theta\kappa}\,\partial^{\kappa}f^{\prime\theta} + 4\,t_1\,\omega_{\iota\kappa\theta}\,\partial^{\kappa}f^{\prime\theta} + 2\,t_1\,\omega_{\theta\kappa\iota}\,\partial^{\kappa}f^{\prime\theta} - 3\,t_1\,\omega_{\iota\alpha}^{\alpha}\,\partial^{\kappa}f_{\kappa}^{\prime} - 3\,t_1\,\omega_{\iota\lambda}^{\lambda}\,\partial^{\kappa}f_{\kappa}^{\prime} - t_1\,\partial_{\kappa}f^{\lambda}{}_{\theta}\,\partial^{\kappa}f_{\lambda}^{\theta} + 2\,t_1\,\partial_{\kappa}f^{\lambda}{}_{\theta}\,\partial^{\kappa}f_{\lambda}^{\theta} - 3\,t_1\,\partial^{\alpha}f^{\lambda}{}_{\alpha}\,\partial^{\kappa}f_{\lambda\kappa} + 2\,r_1\,\partial_{\kappa}\omega^{\alpha\beta\theta}\,\partial^{\kappa}\omega_{\alpha\beta\theta} - 2\,r_1\,\partial_{\kappa}\omega^{\theta\alpha\beta}\,\partial^{\kappa}\omega_{\alpha\beta\theta} + 2\,r_1\,\partial^{\beta}\omega_{\iota}^{\lambda\alpha}\,\partial_{\lambda}\omega_{\alpha\beta}^{\prime} - 8\,r_1\,\partial^{\beta}\omega_{\iota}^{\alpha\lambda}\,\partial_{\lambda}\omega_{\alpha\beta}^{\prime} + 3\,r_5\,\partial_{\alpha}\omega_{\lambda\,\theta}^{\alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa} - 3\,r_5\,\partial_{\theta}\omega_{\lambda\,\alpha}^{\alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}\Big)[t,\,x,\,y,\,z]\,dz\,dy\,dx\,dt$$

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

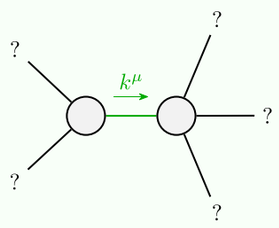
	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$-t_1$	$i\sqrt{2}\,kt_1$	0	0
$f_{0^+}^{\#1}\,\dagger$	$-i\sqrt{2}\,kt_1$	$-2k^2t_1$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	0

	$\omega_{1^+}^{\#1}{}^{\alpha\beta}$	$\omega_{1^+}^{\#2}{}^{\alpha\beta}$	$f_{1^+}^{\#1}{}^{\alpha\beta}$	$\omega_{1^-}^{\#1}{}^{\alpha}$	$\omega_{1^-}^{\#2}{}^{\alpha}$	$f_{1^-}^{\#1}{}^{\alpha}$	$f_{1^-}^{\#2}{}^{\alpha}$
$\omega_{1^+}^{\#1}{}^{\alpha\beta}$	$k^2\,(2r_1+r_5)+\frac{t_1}{6}$	$-\frac{t_1}{3\sqrt{2}}$	$-\frac{ikt_1}{3\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2}{}^{\alpha\beta}$	$-\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	$\frac{ikt_1}{3}$	0	0	0	0
$f_{1^+}^{\#1}{}^{\alpha\beta}$	$\frac{ikt_1}{3\sqrt{2}}$	$\frac{ikt_1}{3}$	$\frac{k^2t_1}{3}$	0	0	0	0
$\omega_{1^-}^{\#1}{}^{\alpha}$	0	0	0	$k^2\,(r_1+r_5)-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	ikt_1
$\omega_{1^-}^{\#2}{}^{\alpha}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1^-}^{\#1}{}^{\alpha}$	0	0	0	0	0	0	$-ikt_1$
$f_{1^-}^{\#2}{}^{\alpha}$	0	0	0	$-ikt_1$	0	$-ikt_1$	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



Quadratic pole	
Pole residue:	$\frac{1}{(2r_1+r_5)\,t_1^{\,2}\,p^2} > 0$
Polarisations:	2

Unitarity conditions

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