Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S_F =$$
$$= \iiint \left[\frac{1}{3}(-3t_1\,\omega_i{}^{\kappa l}\,\omega_{\kappa\lambda}{}^i - t_1\,\omega_i{}^{\kappa\lambda}\,\omega_{\kappa\lambda}{}^i + t_1\,\omega_{\kappa\lambda}{}^i\,\omega^{\kappa\lambda}{}_i + 3\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 3\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} + 6\,r_1\,\partial_i\omega^{\kappa\lambda}{}_\lambda\,\partial^i\omega^\lambda{}_{\lambda\,\alpha} - 2\,r_1\,\partial^\beta\omega^{\theta\alpha}{}_\kappa\,\partial_\theta\omega_\alpha{}^\kappa - 2\,r_1\,\partial_\theta\omega_{\alpha\beta}{}^\kappa\,\partial_\kappa\omega^{\alpha\beta\theta} + \ldots \right] (t, x, y, z)\,dz\,dy\,dx\,dt$$

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\tau_{1^-}^{\#2\,\alpha}$	0	0	0	$\frac{2ik}{t_1+2k^2t_1}$	$\frac{i\sqrt{2}\,k\,(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$	$\frac{2k^2\,(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$	
$\tau_{1^-}^{\#1\,\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#2\,\alpha}$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{2k^2r_1+t_1}{(t_1+2k^2t_1)^2}$	$-\frac{i\sqrt{2}\,k\,(2k^2r_1+t_1)}{(t_1+2k^2t_1)^2}$	
$\sigma_{1^-}^{\#1\,\alpha}$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$-\frac{2ik}{t_1+2k^2t_1}$	
$\tau_{1^+}^{\#1\,\alpha\beta}$	$\frac{6i\sqrt{2}\,k}{(3+2k^2)^2t_1}$	$\frac{12ik}{(3+2k^2)^2t_1}$	$\frac{12k^2}{(3+2k^2)^2t_1}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\frac{6\sqrt{2}}{(3+2k^2)^2t_1}$	$\frac{12}{(3+2k^2)^2t_1}$	$\frac{12ik}{(3+2k^2)^2t_1}$	0	0	0	0
$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\frac{6}{(3+2k^2)^2t_1}$	$\frac{6\sqrt{2}}{(3+2k^2)^2t_1}$	$\frac{6i\sqrt{2}\,k}{(3+2k^2)^2t_1}$	0	0	0	0
	$\sigma_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1^+}^{\#2}\dagger^{\alpha\beta}$	$\tau_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1^-}^{\#1}\dagger^{\alpha}$	$\sigma_{1^-}^{\#2}\dagger^{\alpha}$	$\tau_{1^-}^{\#1}\dagger^{\alpha}$	$\tau_{1^-}^{\#2}\dagger^{\alpha}$

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

	$\omega_{1^-}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#2}{}_\alpha$	$\omega_{1^+}^{\#1}{}_\alpha$	$f_{1^+}^{\#2}$	$\omega_{1^+}^{\#1}$	$\omega_{1^+}^{\#2}$	$f_{1^-}^{\#1}$	$f_{1^-}^{\#2}$
$\omega_{1^-}^{\#2}{}_\alpha$ $f_{1^+}^{\#1}$ $f_{1^+}^{\#2}$	0	0	0	ikt_1	0	0	0	
$\omega_{1^-}^{\#2}{}_\alpha$ $\omega_{1^+}^{\#1}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0	
$\omega_{1^-}^{\#1}$	0	0	0	$-k^2r_1-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	$-ikt_1$		
$f_{1^+}^{\#1}{}_{\alpha\beta}$	$-\frac{ikt_1}{3\sqrt{2}}$	$\frac{ikt_1}{3}$	$\frac{k^2t_1}{3}$	0	0	0	0	
$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$-\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	$-\frac{1}{3}ikt_1$	0	0	0	0	
$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{t_1}{6}$	$-\frac{t_1}{3\sqrt{2}}$	$\frac{ikt_1}{3\sqrt{2}}$	0	0	0	0	
	$\omega_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{1^+}^{\#2}\dagger^{\alpha}$	$f_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{1^-}^{\#1}\dagger^\alpha$	$\omega_{1^-}^{\#2}\dagger^\alpha$	$f_{1^-}^{\#1}\dagger^\alpha$	$f_{1^-}^{\#2}\dagger^\alpha$	

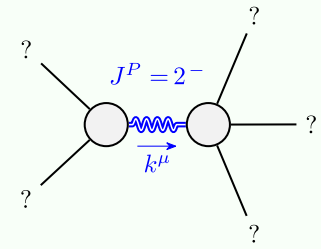|	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$	0	0	$k^2r_1+\frac{t_1}{2}$
$f_{2^+}^{\#1}{}_{\alpha\beta}$	$-\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$\frac{t_1}{2}$	$\frac{ikt_1}{\sqrt{2}}$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

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

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\sigma_{0^-}^{\#1}==0$	1
$\tau_{0^+}^{\#2}==0$	1
$\tau_{0^+}^{\#1}-2i k\sigma_{0^+}^{\#1}==0$	1
$\tau_{1^-}^{\#2\,\alpha}+2 i k\,\sigma_{1^-}^{\#2\,\alpha}==0$	3
$\tau_{1^-}^{\#1\,\alpha}==0$	3
$\tau_{1^+}^{\#1\,\alpha\beta}-2 i k\,\sigma_{1^+}^{\#1\,\alpha\beta}==0$	3
$2\,\sigma_{1^+}^{\#1\,\alpha\beta}+\sigma_{1^+}^{\#2\,\alpha\beta}==0$	3
$\tau_{2^+}^{\#1\,\alpha\beta}-2 i k\,\sigma_{2^+}^{\#1\,\alpha\beta}==0$	5
Total constraints:	20

Massive and massless spectra

Massive particle

$J^P=2^-$	
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

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