Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S_F == \int\int\int\left(\frac{1}{6}(-6t_1\,\omega_l^{\alpha\prime}\,\omega_{\kappa\alpha}{}^{\kappa}-6t_1\,\omega_l{}^{\kappa\lambda}\,\omega_{\kappa\lambda}{}^{\prime}+6\,f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}+6r_1\partial_l\omega^{\kappa\lambda}{}_{\kappa}{}^{\alpha}\partial^{\prime}\omega_{\lambda}{}_{\alpha}{}^{\kappa}-4r_1\partial^{\beta}\omega^{\theta\alpha}{}_{\kappa}{}^{\kappa}\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}-4r_1\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}\partial_{\kappa}\omega^{\alpha\beta\theta}+4r_1\partial_{\theta}\omega_{\alpha}{}^{\kappa}\partial_{\kappa}\omega^{\theta\alpha\beta}+6r_1\partial_{\alpha}\omega_{\lambda}{}_{\theta}{}^{\alpha}\partial_{\kappa}\omega^{\theta\kappa\lambda}-6r_1\partial_{\theta}\omega_{\lambda}{}_{\alpha}{}^{\alpha}\partial_{\kappa}\omega^{\theta\kappa\lambda}+6r_1\partial_{\alpha}\omega_{\lambda}{}_{\theta}{}^{\alpha}\partial_{\kappa}\omega^{\kappa\lambda\theta}-3t_1\partial^{\alpha}f_{\theta\kappa}\partial^{\kappa}f_{\alpha}{}^{\theta}-3t_1\partial^{\alpha}f_{\kappa\theta}\partial^{\kappa}f_{\alpha}{}^{\theta}-3t_1\partial^{\alpha}f_{\kappa}{}^{\lambda}\partial^{\kappa}f_{\alpha\lambda}+12r_1\partial_{\theta}\omega_{\lambda}{}_{\alpha}{}^{\alpha}\partial_{\kappa}\omega^{\kappa\lambda\theta}+6t_1\,\omega_{\kappa\alpha}{}^{\alpha}\partial^{\kappa}f_{l}^{\prime}+6t_1\,\omega_{\kappa\lambda}{}^{\lambda}\partial^{\kappa}f_{l}^{\prime}+12t_1\partial^{\alpha}f_{\kappa\alpha}\partial^{\kappa}f_{l}^{\prime}-6t_1\partial_{\kappa}f^{\lambda}{}_{l}\partial^{\kappa}f_{\lambda}^{\prime}+12t_1\,\omega_{l\kappa\theta}\partial^{\kappa}f^{\prime\theta}-6t_1\,\omega_{l\alpha}{}^{\alpha}\partial^{\kappa}f_{\kappa}^{\prime}-6t_1\,\omega_{l\lambda}{}^{\lambda}\partial^{\kappa}f_{\kappa}^{\prime}+3t_1\partial^{\alpha}f^{\lambda}{}_{\kappa}\partial^{\kappa}f_{\lambda\alpha}+3t_1\partial_{\kappa}f^{\lambda}{}_{\theta}\partial^{\kappa}f_{\lambda}{}^{\theta}-6t_1\partial^{\alpha}f_{\lambda}{}^{\theta}\partial^{\kappa}f_{\alpha}{}^{\lambda}+4r_1\partial_{\kappa}\omega^{\alpha\beta\theta}\partial^{\kappa}\omega_{\alpha\beta\theta}{}^{\prime}+4r_1\partial^{\beta}\omega_{l}{}^{\alpha\lambda}\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime}-16r_1\partial^{\beta}\omega_{l}{}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime}+6r_1\partial_{\theta}\omega_{\lambda}{}_{\alpha}{}^{\alpha}\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}{}^{\prime}+6r_1\partial_{\theta}\omega_{\lambda}{}_{\alpha}{}^{\alpha}\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa})\right)[t,x,y,z]\,dz\,dy\,dx\,dt$$

	$\sigma_1^{\#1}{}_\alpha$	$\sigma_1^{\#2}{}_\alpha$	$\tau_1^{\#1}{}_\alpha$	$\tau_1^{\#2}{}_\alpha$
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{i(2k^3 r_1-k t_1)}{(1+k^2)^2 t_1^2}$	0
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	0	$\frac{i(2k^3 r_1-k t_1)}{(1+k^2)^2 t_1^2}$	$\frac{-2k^4 r_1+k^2 t_1}{(1+k^2)^2 t_1^2}$	0
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	$\frac{2ik}{t_1+2k^2 t_1}$	$\frac{2ik}{t_1+2k^2 t_1}$
$\sigma_{1^-}^{\#2}{}_{\alpha}$	0	$\frac{1}{(1+2k^2)^2 t_1}$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$
$\tau_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0
$\tau_{1^-}^{\#2}{}_{\alpha}$	0	$-\frac{2ik}{t_1+2k^2 t_1}$	0	$\frac{2k^2}{(1+2k^2)^2 t_1}$

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

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

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

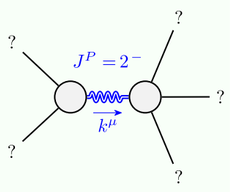
	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$-t_1$	$i\sqrt{2}\,k t_1$	$-2k^2 t_1$	0
$f_{0^+}^{\#1}\,\dagger$	$-i\sqrt{2}\,k t_1$	0	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	$-t_1$

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

Source constraints/gauge generators

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

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

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