Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$
\begin{aligned}
S_F == \iiint\!\!\int \tfrac{1}{6}\,(-2\,(t_1-2\,t_3)\;\omega_{\iota}^{\alpha\prime}\;\omega_{\kappa\alpha}^{\kappa}-6\,t_1\;\omega_{\iota}^{\kappa}\;\omega_{\kappa\lambda}^{\prime}+6\;f^{\alpha\beta}\;\tau_{\alpha\beta}+6\;\omega^{\alpha\beta\chi}\;\sigma_{\alpha\beta\chi}+\\
4\,r_2\,\partial^{\beta}\omega^{\theta\alpha}{}_{\kappa}\,\partial_{\theta}\omega_{\alpha\beta}^{\kappa}-4\,r_2\,\partial_{\kappa}\omega^{\alpha\beta\theta}\,\partial_{\theta}\omega_{\alpha\beta}-4\,r_2\,\partial_{\theta}\omega_{\alpha\beta}\,\partial_{\kappa}\omega^{\theta\alpha\beta}-\\
3\,t_1\,\partial^{\alpha}f_{\theta\kappa}\,\partial^{\kappa}f_{\alpha}{}^{\theta}-3\,t_1\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\alpha\lambda}+2\,t_1\;\omega_{\kappa\alpha}{}^{\alpha}\,\partial^{\kappa}f^{\prime}{}_{\iota}-\\
4\,t_3\;\omega_{\kappa\alpha}{}^{\alpha}\,\partial^{\kappa}f^{\prime}{}_{\iota}+2\,t_1\;\omega_{\kappa\lambda}{}^{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\iota}-4\,t_3\;\omega_{\kappa\lambda}{}^{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\iota}+4\,t_1\,\partial^{\alpha}f_{\kappa\alpha}\,\partial^{\kappa}f^{\prime}{}_{\iota}+\\
8\,t_3\,\partial^{\alpha}f_{\kappa\alpha}\,\partial^{\kappa}f^{\prime}{}_{\iota}-2\,t_1\,\partial_{\kappa}f^{\lambda}{}_{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\iota}+12\,t_1\;\omega_{\iota\kappa\theta}\,\partial^{\kappa}f^{\prime\theta}-\\
2\,t_1\;\omega_{\iota\alpha}{}^{\alpha}\,\partial^{\kappa}f^{\prime}{}_{\kappa}+4\,t_3\;\omega_{\iota\alpha}{}^{\alpha}\,\partial^{\kappa}f^{\prime}{}_{\kappa}-2\,t_1\;\omega_{\iota\lambda}{}^{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\kappa}+4\,t_3\;\omega_{\iota\lambda}{}^{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\kappa}+\\
3\,t_1\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\lambda\alpha}+3\,t_1\,\partial_{\kappa}f^{\lambda}{}_{\theta}\,\partial^{\kappa}f_{\lambda}{}^{\theta}-2\,t_1\,\partial^{\alpha}f^{\lambda}{}_{\alpha}\,\partial^{\kappa}f_{\lambda\kappa}+\\
4\,t_3\,\partial^{\alpha}f^{\lambda}{}_{\alpha}\,\partial^{\kappa}f_{\lambda\kappa}+2\,r_2\,\partial_{\kappa}\omega^{\alpha\beta\theta}\,\partial^{\kappa}\omega_{\alpha\beta\theta}+4\,r_2\,\partial_{\kappa}\omega^{\theta\alpha\beta}\,\partial^{\kappa}\omega_{\alpha\beta\theta}-\\
4\,r_2\,\partial^{\beta}\omega_{\iota}{}^{\lambda\alpha}\,\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime}+4\,r_2\,\partial^{\beta}\omega_{\iota}{}^{\alpha\lambda}\,\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime})[t,\,x,\,y,\,z]\,d\,z\,d\,y\,d\,x\,d\,t
\end{aligned}
$$

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

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

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

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

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

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

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

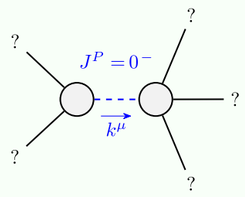
	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	0
$\tau_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	0
$\sigma_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	$\frac{2}{t_1}$

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

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

Massive and massless spectra



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

$r_2 < 0$ && $t_1 < 0$