Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S == \iiint\left(\frac{1}{6}\left(6\,f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}-3\,r_3\,\partial_\iota\omega_\beta{}^\theta\,\partial^\iota\omega^{\alpha\beta}{}_\alpha-3\,r_3\,\partial_\iota\omega_\beta{}^\theta\,\partial^\beta\omega^{\alpha\iota}{}_\alpha-3\,r_3\,\partial^\iota\omega^{\alpha\beta}{}_\alpha\,\partial_\theta\omega_\beta{}^\theta-3\,r_3\,\partial_\alpha\omega^{\alpha\beta\iota}\,\partial_\theta\omega_\beta{}^\theta+6\,r_3\,\partial^\iota\omega^{\alpha\beta}{}_\alpha\,\partial_\theta\omega_\iota{}^\theta{}_\beta+6\,r_3\,\partial_\alpha\omega^{\alpha\beta\iota}\,\partial_\theta\omega_\iota{}^\theta{}_\beta+4\,t_2\,\omega_{\iota\theta\alpha}\,\partial^\theta f^{\alpha\iota}+2\,t_2\,\partial_\alpha f_{\iota\theta}\,\partial^\theta f^{\alpha\iota}-t_2\,\partial_\alpha f_{\theta\iota}\,\partial^\theta f^{\alpha\iota}-t_2\,\partial_\theta f_{\alpha\iota}\,\partial^\theta f^{\alpha\iota}-t_2\,\partial_\theta f_{\iota\alpha}\,\partial^\theta f^{\alpha\iota}-4\,t_2\,\omega_{\alpha\theta\iota}\,(\omega^{\alpha\iota\theta}+\partial^\theta f^{\alpha\iota})+2\,t_2\,\omega_{\alpha\iota\theta}\,(\omega^{\alpha\iota\theta}+2\,\partial^\theta f^{\alpha\iota})+8\,r_2\,\partial_\beta\omega_{\alpha\iota\theta}\,\partial^\theta\omega^{\alpha\beta\iota}-4\,r_2\,\partial_\beta\omega_{\alpha\theta\iota}\,\partial^\theta\omega^{\alpha\beta\iota}+4\,r_2\,\partial_\beta\omega_{\iota\theta\alpha}\,\partial^\theta\omega^{\alpha\beta\iota}-24\,r_3\,\partial_\beta\omega_{\iota\theta\alpha}\,\partial^\theta\omega^{\alpha\beta\iota}-2\,r_2\,\partial_\iota\omega_{\alpha\beta\theta}\,\partial^\theta\omega^{\alpha\beta\iota}+2\,r_2\,\partial_\theta\omega_{\alpha\beta\iota}\,\partial^\theta\omega^{\alpha\beta\iota}-4\,r_2\,\partial_\theta\omega_{\alpha\iota\beta}\,\partial^\theta\omega^{\alpha\beta\iota}+6\,r_5\,\partial_\iota\omega_\theta{}^\kappa\,\partial^\theta\omega^{\alpha\iota}{}_\alpha\,\partial_\theta\omega_\kappa{}^\theta-6\,r_5\,\partial_\alpha\omega^{\alpha\iota\theta}\,\partial_\kappa\omega_\iota{}^\theta+12\,r_5\,\partial^\theta\omega^{\alpha\iota}{}_\alpha\,\partial_\kappa\omega_\iota{}^\kappa{}_\theta+6\,r_5\,\partial_\alpha\omega^{\alpha\iota\theta}\,\partial_\kappa\omega_\theta{}^\kappa{}_\iota-12\,r_5\,\partial^\theta\omega^{\alpha\iota}{}_\alpha\,\partial_\kappa\omega_\theta{}^\kappa{}_\iota)\right)[t,\,x,\,y,\,z]\,dz\,dy\,dx\,dt$$

	$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
$\sigma_{1^+}^{\#1\,\dagger}{}^{\alpha\beta}$	$-\frac{1}{k^2\,(2\,r_3+r_5)}$	$-\frac{i\,\sqrt{2}}{k\,(1+k^2)\,(2\,r_3+r_5)}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\dagger}{}^{\alpha\beta}$	$-\frac{\sqrt{2}}{k^2\,(1+k^2)\,(2\,r_3+r_5)}$	$\frac{i\,(3\,k^2\,(2\,r_3+r_5)+2\,t_2)}{k\,(1+k^2)^2\,(2\,r_3+r_5)\,t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\dagger}{}^{\alpha\beta}$	$\frac{\sqrt{2}}{k^2\,(1+k^2)\,(2\,r_3+r_5)}$	$-\frac{i\,(3\,k^2\,(2\,r_3+r_5)+2\,t_2)}{k\,(1+k^2)^2\,(2\,r_3+r_5)\,t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\dagger}{}^{\alpha}$	0	0	$\frac{2}{k^2\,(r_3+2\,r_5)}$	0	0	0
$\sigma_{1^-}^{\#2\,\dagger}{}^{\alpha}$	0	0	0	0	0	0
$\tau_{1^-}^{\#1\,\dagger}{}^{\alpha}$	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\dagger}{}^{\alpha}$	0	0	0	0	0	0

	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^+}^{\#1\,\dagger}{}^{\alpha\beta}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	0	0	0	0
$\omega_{1^+}^{\#2\,\dagger}{}^{\alpha\beta}$	$\frac{t_2}{3}$	$\frac{i\,k\,t_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\dagger}{}^{\alpha\beta}$	$-\frac{1}{3}\,i\,k\,t_2$	$\frac{k^2\,t_2}{3}$	0	0	0	0
$\omega_{1^-}^{\#1\,\dagger}{}^{\alpha}$	0	0	$\frac{1}{2}\,k^2\,(r_3+2\,r_5)$	0	0	0
$\omega_{1^-}^{\#2\,\dagger}{}^{\alpha}$	0	0	0	0	0	0
$f_{1^-}^{\#1\,\dagger}{}^{\alpha}$	0	0	0	0	0	0
$f_{1^-}^{\#2\,\dagger}{}^{\alpha}$	0	0	0	0	0	0

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1\,\dagger}$	0	0	0	0
$\tau_{0^+}^{\#1\,\dagger}$	0	0	0	0
$\tau_{0^+}^{\#2\,\dagger}$	0	0	0	0
$\sigma_{0^-}^{\#1\,\dagger}$	0	0	0	$\frac{1}{k^2\,r_2+t_2}$

	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1\,\dagger}{}^{\alpha\beta}$	$-\frac{2}{3\,k^2\,r_3}$	0	0
$\tau_{2^+}^{\#1\,\dagger}{}^{\alpha\beta}$	0	0	0
$\sigma_{2^-}^{\#1\,\dagger}{}^{\alpha\beta\chi}$	0	0	0

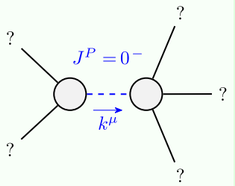
	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1\,\dagger}$	0	0	0	0
$f_{0^+}^{\#1\,\dagger}$	0	0	0	0
$f_{0^+}^{\#2\,\dagger}$	0	0	0	0
$\omega_{0^-}^{\#1\,\dagger}$	0	0	0	$k^2\,r_2+t_2$

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1\,\dagger}{}^{\alpha\beta}$	$-\frac{3\,k^2\,r_3}{2}$	0	0
$f_{2^+}^{\#1\,\dagger}{}^{\alpha\beta}$	0	0	0
$\omega_{2^-}^{\#1\,\dagger}{}^{\alpha\beta\chi}$	0	0	0

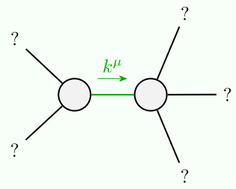
Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} == 0$	1
$\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\sigma_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	3
$\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	25

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd



Quadratic pole	
Pole residue:	$-\frac{1}{r_3\,(2\,r_3+r_5)\,(r_3+2\,r_5)\,p^2} > 0$
Polarisations:	2

Unitarity conditions

$$r_2 < 0 \,\&\&\, r_3 < 0 \,\&\&\, r_5 < -\frac{r_3}{2} \,\&\&\, t_2 > 0 \,\|\, r_2 < 0 \,\&\&\, r_3 < 0 \,\&\&\, r_5 > -2\,r_3 \,\&\&\, t_2 > 0 \,\|\, r_2 < 0 \,\&\&\, r_3 > 0 \,\&\&\, -2\,r_3 < r_5 < -\frac{r_3}{2} \,\&\&\, t_2 > 0$$