Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$\mathcal{S} == \int\int\int\int(f^{\alpha\beta}\ \tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\ \sigma_{\alpha\beta\chi} + \frac{1}{6}\ t_1\ (2\ \omega^{\alpha\iota}{}_{\alpha}{}^{\theta}\ \omega_{\iota}{}_{\theta}{}^{\alpha} - 4\ \omega_{\alpha}{}^{\theta}{}_{\theta}\ \partial_{\iota} f^{\alpha\iota} + 4\ \omega_{\iota}{}_{\theta}{}^{\theta}\ \partial^{\prime} f^{\alpha}{}_{\alpha} - 2\ \partial_{\iota} f^{\theta}{}_{\theta}\ \partial^{\prime} f^{\alpha}{}_{\alpha} - 2\ \partial_{\iota} f^{\alpha\iota}{}_{\alpha}\ \partial_{\theta} f^{\theta}{}_{\iota} + 4\ \partial^{\prime} f^{\alpha}{}_{\alpha}\ \partial_{\theta} f^{\theta}{}_{\iota} - 6\ \partial_{\alpha} f_{\iota\theta}\ \partial^{\theta} f^{\alpha\iota} - 3\ \partial_{\alpha} f_{\theta\iota}\ \partial^{\theta} f^{\alpha\iota} + 3\ \partial_{\iota} f_{\alpha\theta}\ \partial^{\theta} f^{\alpha\iota} + 3\ \partial_{\theta} f_{\alpha\iota}\ \partial^{\theta} f^{\alpha\iota} + 6\ \omega_{\alpha\theta\iota}\ (\omega^{\alpha\iota\theta} + 2\ \partial^{\theta} f^{\alpha\iota})) - 4\ r_3\ (\partial_{\beta}\omega_{\iota}{}_{\theta}{}^{\theta}\ \partial^{\prime}\omega^{\alpha\beta}{}_{\alpha} + \partial_{\alpha}\omega^{\alpha\beta\iota}\ \partial_{\theta}\omega_{\iota}{}_{\beta}{}^{\theta} - 2\ \partial^{\prime}\omega^{\alpha\beta}{}_{\alpha}\ \partial_{\theta}\omega_{\iota}{}_{\beta}{}^{\theta} + \partial_{\beta}\omega_{\iota\theta\alpha}\ \partial^{\theta}\omega^{\alpha\beta\iota}) + \frac{1}{3}\ r_1\ (9\ \partial_{\beta}\omega_{\iota}{}_{\theta}{}^{\theta}\ \partial^{\prime}\omega^{\alpha\beta}{}_{\alpha} + 3\ \partial_{\iota}\omega_{\beta}{}_{\theta}{}^{\theta}\ \partial^{\prime}\omega^{\alpha\beta}{}_{\alpha} + 3\ \partial_{\alpha}\omega^{\alpha\beta\iota}\ \partial_{\theta}\omega_{\beta}{}_{\iota}{}^{\theta} - 6\ \partial^{\prime}\omega^{\alpha\beta}{}_{\alpha}\ \partial_{\theta}\omega_{\iota}{}_{\beta}{}^{\theta} + 9\ \partial_{\alpha}\omega^{\alpha\beta\iota}\ \partial_{\theta}\omega_{\beta}{}_{\iota}{}^{\theta} - 18\ \partial^{\prime}\omega^{\alpha\beta}{}_{\alpha}\ \partial_{\theta}\omega_{\iota}{}_{\beta}{}^{\theta} + 4\ \partial_{\beta}\omega_{\alpha\iota\theta}\ \partial^{\theta}\omega^{\alpha\beta\iota} + 4\ \partial_{\beta}\omega_{\iota\theta\alpha}\ \partial^{\theta}\omega^{\alpha\beta\iota} - 2\ \partial_{\iota}\omega_{\alpha\beta\theta}\ \partial^{\theta}\omega^{\alpha\beta\iota} + 2\ \partial_{\theta}\omega_{\alpha\beta\iota}\ \partial^{\theta}\omega^{\alpha\beta\iota}))[t,\ x,\ y,\ z]\ dt\ dx\ dy\ dz$$

$\sigma_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
0	$-\frac{\sqrt{2}}{t_1+k^2\,t_1}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2\,t_1}$	0	0	0	0
$-\frac{\sqrt{2}}{t_1+k^2\,t_1}$	$\frac{-2k^2\,r_1+t_1}{(1+k^2)^2\,t_1^2}$	$-\frac{i(2k^3\,r_1-kt_1)}{(1+k^2)^2\,t_1^2}$	0	0	0	0
$\frac{i\sqrt{2}\,k}{t_1+k^2\,t_1}$	$\frac{i(2k^3\,r_1-kt_1)}{(1+k^2)^2\,t_1^2}$	$\frac{-2k^4\,r_1+k^2\,t_1}{(1+k^2)^2\,t_1^2}$	0	0	0	0
0	0	0	$\frac{6}{(3+4k^2)^2\,t_1}$	$\frac{6\sqrt{2}}{(3+4k^2)^2\,t_1}$	0	$\frac{12ik}{(3+4k^2)^2\,t_1}$
0	0	0	$\frac{6\sqrt{2}}{(3+4k^2)^2\,t_1}$	$\frac{12}{(3+4k^2)^2\,t_1}$	0	$\frac{12i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$
0	0	0	0	0	0	0
0	0	0	$-\frac{12ik}{(3+4k^2)^2\,t_1}$	$-\frac{12i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$	0	$\frac{24k^2}{(3+4k^2)^2\,t_1}$

$\omega_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$k^2\,r_1-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
0	0	0	$\frac{ikt_1}{3}$	$\frac{t_1}{3\sqrt{2}}$	0	0
0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	$\frac{1}{3}i\sqrt{2}\,kt_1$	0
0	0	0	0	0	0	$\frac{2k^2t_1}{3}$
0	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}\,kt_1$	0	$\frac{2k^2t_1}{3}$

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

$\omega_{0^+}^{\#1}{}^{\dagger}$	$f_{0^+}^{\#1}{}^{\dagger}$	$f_{0^+}^{\#2}{}^{\dagger}$	$\omega_{0^-}^{\#1}{}^{\dagger}$
$\omega_{0^+}^{\#1}{}^{\dagger}$	$6k^2(-r_1+r_3)$	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	$-t_1$

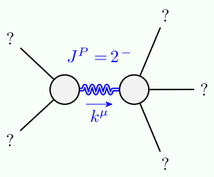
$\omega_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	$k^2\,t_1$	0
$\omega_{2^-}^{\#1}{}^{\dagger\alpha\beta\chi}$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

$\sigma_{0^+}^{\#1}{}^{\dagger}$	$\tau_{0^+}^{\#1}{}^{\dagger}$	$\tau_{0^+}^{\#2}{}^{\dagger}$	$\sigma_{0^-}^{\#1}{}^{\dagger}$
$\sigma_{0^+}^{\#1}{}^{\dagger}$	$\frac{1}{6k^2(-r_1+r_3)}$	0	0	$-\frac{1}{t_1}$
$\tau_{0^+}^{\#1}{}^{\dagger}$	0	0	0	0
$\tau_{0^+}^{\#2}{}^{\dagger}$	0	0	0	0
$\sigma_{0^-}^{\#1}{}^{\dagger}$	0	0	0	0

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\ \sigma_{1^-}^{\#1\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\sigma_{1^-}^{\#1\,\alpha} == \sigma_{1^-}^{\#2\,\alpha}$	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:	19

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2\,r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

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