Particle spectrograph

Wave operator and propagator

Quadratic (free) action

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

	$\sigma_1^{\#1\dagger\,\alpha\beta}$	$\sigma_1^{\#2\dagger\,\alpha\beta}$	$\tau_1^{\#1\dagger\,\alpha\beta}$	$\sigma_1^{\#1-\dagger\,\alpha}$	$\sigma_1^{\#2\dagger\,\alpha}$	$\tau_1^{\#1\dagger\,\alpha}$	$\tau_1^{\#2\dagger\,\alpha}$
$\tau_1^{\#2}{}_\alpha$	0	0	0	0	0	0	0
$\tau_1^{\#1}{}_\alpha$	0	0	0	0	0	0	0
$\sigma_1^{\#2}{}_\alpha$	0	0	0	0	0	0	0
$\sigma_1^{\#1-}{}_\alpha$	0	0	0	$\frac{1}{k^2 r_5}$	0	0	0
$\tau_1^{\#1}{}_{+\,\alpha\beta}$	$-\frac{i\sqrt{2}}{k r_5 + k^3 r_5}$	$\frac{i(3 k^2 r_5 + 2 t_2)}{k(1+k^2)^2 r_5 t_2}$	$\frac{3 k^2 r_5 + 2 t_2}{(1+k^2)^2 r_5 t_2}$	0	0	0	0
$\sigma_1^{\#2}{}_{+\,\alpha\beta}$	$-\frac{\sqrt{2}}{k^2 r_5 + k^4 r_5}$	$\frac{3 k^2 r_5 + 2 t_2}{(k+k^3)^2 r_5 t_2}$	$-\frac{i(3 k^2 r_5 + 2 t_2)}{k(1+k^2)^2 r_5 t_2}$	0	0	0	0
$\sigma_1^{\#1}{}_{+\,\alpha\beta}$	$\frac{1}{k^2 r_5}$	$-\frac{\sqrt{2}}{k^2 r_5 + k^4 r_5}$	$\frac{i\sqrt{2}}{k r_5 + k^3 r_5}$	0	0	0	0

	$\omega_1^{\#1\dagger\,\alpha\beta}$	$\omega_1^{\#2\dagger\,\alpha\beta}$	$f_1^{\#1\dagger\,\alpha\beta}$	$\omega_1^{\#1\dagger\,\alpha}$	$\omega_1^{\#2\dagger\,\alpha}$	$f_1^{\#1\dagger\,\alpha}$	$f_1^{\#2\dagger\,\alpha}$
$f_1^{\#2}{}_\alpha$	0	0	0	0	0	0	0
$f_1^{\#1}{}_\alpha$	0	0	0	0	0	0	0
$\omega_1^{\#2}{}_\alpha$	0	0	0	0	0	0	0
$\omega_1^{\#1-}{}_\alpha$	0	0	0	$k^2 r_5$	0	0	0
$f_1^{\#1}{}_{+\,\alpha\beta}$	$\sqrt{2}\, k t_2$	0	0	0	0	0	0
$\omega_1^{\#2}{}_{+\,\alpha\beta}$	$\frac{1}{3} i \sqrt{2}\, k t_2$	$\frac{i k t_2}{3}$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_1^{\#1}{}_{+\,\alpha\beta}$	$k^2 r_5 + \frac{2 t_2}{3}$	$\frac{\sqrt{2}\, t_2}{3}$	$\frac{t_2}{3}$	0	0	0	0
		$\frac{\sqrt{2}\, t_2}{3}$	$-\frac{1}{3} i \sqrt{2}\, k t_2$				
		$-\frac{1}{3} i \sqrt{2}\, k t_2$					
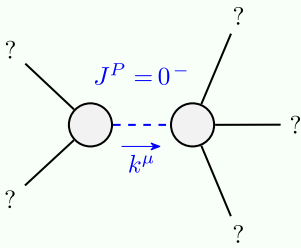
	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\dagger$	0	0	0	0
$f_{0^+}^{\#1}\dagger$	0	0	0	0
$f_{0^+}^{\#2}\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\dagger$	0	0	0	$k^2 r_2 + t_2$

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

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
$\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	30

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

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$f_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$\omega_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	0

Massive and massless spectra

$J^P = 0^-$

k^μ

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

(No massless particles)

Unitarity conditions

$r_2 < 0 \ \&\& \ t_2 > 0$