

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S = \int \int \int \int \left[ \frac{1}{6} (6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 12 r_1 \partial_\beta \omega_{,\theta}^\theta \partial' \omega_{\alpha}^{\alpha\beta} - 24 r_3 \partial_\beta \omega_{,\theta}^\theta \partial' \omega_{\alpha}^{\alpha\beta} + 12 r_1 \partial_i \omega_{\beta}^\theta \partial' \omega_{\alpha}^{\alpha\beta} + 12 r_1 \partial_\alpha \omega^{\alpha\beta i} \partial_\theta \omega_{\beta,}^\theta - 24 r_1 \partial' \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{\beta,}^\theta + 12 r_1 \partial_\alpha \omega^{\alpha\beta i} \partial_\theta \omega_{,\beta}^\theta - 24 r_3 \partial_\alpha \omega^{\alpha\beta i} \partial_\theta \omega_{,\beta}^\theta - 24 r_1 \partial' \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{,\beta}^\theta + 48 r_3 \partial' \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{,\beta}^\theta + 4 t_2 \omega_{,\theta}^\theta \partial^\theta f^{\alpha i} + 2 t_2 \partial_\alpha f_{,\theta}^\theta \partial^\theta f^{\alpha i} - t_2 \partial_\alpha f_{,\theta}^\theta \partial^\theta f^{\alpha i} - t_2 \partial_\alpha f_{,\theta}^\theta \partial^\theta f^{\alpha i} + t_2 \partial_\alpha f_{,\theta}^\theta \partial^\theta f^{\alpha i} + 2 t_2 \omega_{,\alpha i \theta} (\omega^{\alpha i \theta} + 2 \partial^\theta f^{\alpha i}) - 8 r_1 \partial_\beta \omega_{\alpha i \theta} \partial^\theta \omega^{\alpha \beta i} + 8 r_2 \partial_\beta \omega_{\alpha i \theta} \partial^\theta \omega^{\alpha \beta i} + 4 r_1 \partial_\beta \omega_{\alpha \theta i} \partial^\theta \omega^{\alpha \beta i} - 4 r_2 \partial_\beta \omega_{\alpha \theta i} \partial^\theta \omega^{\alpha \beta i} + 8 r_1 \partial_\beta \omega_{,\theta}^\theta \partial^\theta \omega^{\alpha \beta i} + 4 r_2 \partial_\beta \omega_{,\theta}^\theta \partial^\theta \omega^{\alpha \beta i} - 24 r_3 \partial_\beta \omega_{,\theta}^\theta \partial^\theta \omega^{\alpha \beta i} - 4 r_1 \partial_i \omega_{\alpha \beta \theta} \partial^\theta \omega^{\alpha \beta i} - 2 r_2 \partial_i \omega_{\alpha \beta \theta} \partial^\theta \omega^{\alpha \beta i} + 4 r_1 \partial_\theta \omega_{\alpha \beta i} \partial^\theta \omega^{\alpha \beta i} + 2 r_2 \partial_\theta \omega_{\alpha \beta i} \partial^\theta \omega^{\alpha \beta i} + 4 r_1 \partial_\theta \omega_{\alpha i \beta} \partial^\theta \omega^{\alpha \beta i} - 4 r_2 \partial_\theta \omega_{\alpha i \beta} \partial^\theta \omega^{\alpha \beta i} ) ] [t, x, y, z] dz dy dx dt$$

	$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_{0-}^{\#1}$		$\omega_{2+}^{\#1}$	$f_{2+}^{\#1}$	$\omega_{2-}^{\#1}$		$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\omega_{0+}^{\#1} \dagger$	$6 k^2 (-r_1 + r_3)$	0	0	0		$\omega_{2+}^{\#1} \dagger^{\alpha\beta}$	0	0	0	$\sigma_{0+}^{\#1} \dagger$	$\frac{1}{6 k^2 (-r_1 + r_3)}$	0	0
$f_{0+}^{\#1} \dagger$	0	0	0	0		$f_{2+}^{\#1} \dagger^{\alpha\beta}$	0	0	0	$\tau_{0+}^{\#1} \dagger$	0	0	0
$f_{0+}^{\#2} \dagger$	0	0	0	0		$\omega_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$k^2 r_1$	$\tau_{0+}^{\#2} \dagger$	0	0	0
$\omega_{0-}^{\#1} \dagger$	0	0	0	$k^2 r_2 + t_2$						$\sigma_{0-}^{\#1} \dagger$	0	0	$\frac{1}{k^2 r_2 + t_2}$

	$\omega_{1+}^{\#1}$	$\omega_{1+}^{\#2}$	$f_{1+}^{\#1}$	$\omega_{1-}^{\#1}$	$\omega_{1-}^{\#2}$	$f_{1-}^{\#1}$	$f_{1-}^{\#2}$
$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{2 t_2}{3}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{1}{3} i \sqrt{2} k t_2$	0	0	0	0
$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$\frac{\sqrt{2} t_2}{3}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{1}{3} i \sqrt{2} k t_2$	$-\frac{1}{3} i k t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	$-k^2 r_1$	0	0	0
$\omega_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	0	0	0	0

	$\sigma_{1+}^{\#1}$	$\sigma_{1+}^{\#2}$	$\tau_{1+}^{\#1}$	$\sigma_{1-}^{\#1}$	$\sigma_{1-}^{\#2}$	$\tau_{1-}^{\#1}$	$\tau_{1-}^{\#2}$
$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{6}{(3+k^2)^2 t_2}$	$\frac{3 \sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3 i \sqrt{2} k}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$	$\frac{3 \sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3}{(3+k^2)^2 t_2}$	$\frac{3 i k}{(3+k^2)^2 t_2}$	0	0	0	0
$\tau_{1+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{3 i \sqrt{2} k}{(3+k^2)^2 t_2}$	$-\frac{3 i k}{(3+k^2)^2 t_2}$	$\frac{3 k^2}{(3+k^2)^2 t_2}$	$-\frac{1}{k^2 r_1}$	0	0	0
$\sigma_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	0	0	0	0

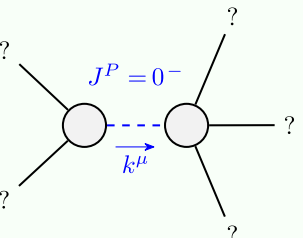
	$\sigma_{2+}^{\#1}$	$\tau_{2+}^{\#1}$	$\sigma_{2-}^{\#1}$
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$\frac{1}{k^2 r_1}$

	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$\frac{1}{6 k^2 (-r_1 + r_3)}$	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
$\tau_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i k \sigma_{1+}^{\#1\alpha\beta} == 0$	3
$\sigma_{1+}^{\#1\alpha\beta} == \sigma_{1+}^{\#2\alpha\beta}$	3
$\tau_{2+}^{\#1\alpha\beta} == 0$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	27

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

(No massless particles)  
(seeipole on N)

Unitarity conditions

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