

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$S=$$

$$\iiint (\frac{1}{6} (6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 15 r_3 \partial_\beta \omega_{,\theta}^\theta \partial'_\theta \omega_{\beta}^{\alpha\beta} + 9 r_3 \partial_\beta \omega_{\beta}^\theta \partial'_\theta \omega_{\alpha}^{\alpha\beta} + 9 r_3 \partial_\alpha \omega^{\alpha\beta\prime} \partial_\theta \omega_{\beta,\prime}^\theta - 18 r_3 \partial'_\theta \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{\beta,\prime}^\theta - 15 r_3 \partial_\alpha \omega^{\alpha\beta\prime} \partial_\theta \omega_{\beta,\prime}^\theta + 30 r_3 \partial'_\theta \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{\beta,\prime}^\theta + 4 t_2 \omega_{,\theta\alpha} \partial^\theta f^{\alpha\prime} + 2 t_2 \partial_\theta f_{,\theta\alpha} \partial^\theta f^{\alpha\prime} - t_2 \partial_\theta f_{,\theta} \partial^\theta f^{\alpha\prime} - t_2 \partial_\theta f_{\theta,\prime} \partial^\theta f^{\alpha\prime} - t_2 \partial_\theta f_{\theta,\prime} \partial^\theta f^{\alpha\prime}) + t_2 \partial_\theta f_{\alpha\theta} \partial^\theta f^{\alpha\prime} + t_2 \partial_\theta f_{\alpha,\prime} \partial^\theta f^{\alpha\prime} - t_2 \partial_\theta f_{,\alpha} \partial^\theta f^{\alpha\prime} - 4 t_2 \omega_{\alpha\theta,\prime} (\omega^{\alpha\theta} + \partial^\theta f^{\alpha\prime}) + 2 t_2 \omega_{\alpha\theta} (\omega^{\alpha\theta} + 2 \partial^\theta f^{\alpha\prime}) + 8 r_2 \partial_\beta \omega_{\alpha\theta} \partial^\theta \omega_{\alpha\beta\prime} - 4 r_2 \partial_\beta \omega_{\alpha\theta,\prime} \partial^\theta \omega_{\alpha\beta\prime} + 4 r_2 \partial_\beta \omega_{,\theta\alpha} \partial^\theta \omega_{\alpha\beta\prime} - 24 r_3 \partial_\beta \omega_{,\theta\alpha} \partial^\theta \omega_{\alpha\beta\prime} - 2 r_2 \partial_\beta \omega_{\alpha\theta\theta} \partial^\theta \omega_{\alpha\beta\prime} + 2 r_2 \partial_\theta \omega_{\alpha\beta\prime} \partial^\theta \omega_{\alpha\beta\prime} - 4 r_2 \partial_\theta \omega_{\alpha\beta} \partial^\theta \omega^{\alpha\beta\prime})) [t, x, y, z] dz dy dx dt$$

	$\omega_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1^+}^{\#2} \dagger^{\alpha\beta}$	$f_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1^+}^{\#1} \dagger^{\alpha}$	$\omega_{1^+}^{\#2} \dagger^{\alpha}$	$f_{1^+}^{\#1} \dagger^{\alpha}$	$f_{1^+}^{\#2} \dagger^{\alpha}$
$\omega_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\omega_{1^+}^{\#2} \dagger^{\alpha\beta}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$f_{1^+}^{\#1} \dagger^{\alpha\beta}$	$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}iikt_2$	$\frac{k^2t_2}{3}$	0	0	0	0
$\omega_{1^+}^{\#1} \dagger^{\alpha}$	0	0	0	$-\frac{3k^2r_3}{2}$	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

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

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

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

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
$\tau_{1^+}^{\#1\alpha\beta} + ik\sigma_{1^+}^{\#1\alpha\beta} == 0$	3
$\sigma_{1^+}^{\#1\alpha\beta} == \sigma_{1^+}^{\#2\alpha\beta}$	3
$\sigma_{2^+}^{\#1\alpha\beta\chi} == 0$	5
$\tau_{2^+}^{\#1\alpha\beta} == 0$	5
Total constraints:	28

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

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)

Unitarity conditions

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