

Particle spectrograph

Wave operator and propagator

Quadratic (free) action

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

$\sigma_{2+}^{\#1} \sigma_{2-}^{\#1}$

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

$\omega_{0+}^{\#1} \omega_{0-}^{\#1}$

$\omega_{0+}^{\#1} +$	0
$\omega_{0-}^{\#1} +$	$k^2 r_2$

$\sigma_{0+}^{\#1} \sigma_{0-}^{\#1}$

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

$\omega_{2+}^{\#1} \omega_{2-}^{\#1}$

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

$\sigma_{1+}^{\#1} \sigma_{1-}^{\#1}$

$\sigma_{1+}^{\#1} + \alpha\beta$	$\frac{1}{k^2 (2r_3 + r_5)}$	0	0	0
$\sigma_{1+}^{\#2} + \alpha\beta$	0	0	0	0
$\sigma_{1-}^{\#1} + \alpha$	0	0	$\frac{2}{k^2 (r_3 + 2r_5)}$	0
$\sigma_{1-}^{\#2} + \alpha$	0	0	0	0

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\sigma_{0+}^{\#1} == 0$	1
$\sigma_{1-}^{\#2\alpha} == 0$	3
$\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	5
Total constraints:	12

$\omega_{1+}^{\#1} \omega_{1-}^{\#1}$

$\omega_{1+}^{\#1} + \alpha\beta$	0	0	$\frac{1}{2} k^2 (r_3 + 2r_5)$	0
$\omega_{1+}^{\#2} + \alpha\beta$	0	0	0	0
$\omega_{1-}^{\#1} + \alpha$	0	0	0	0
$\omega_{1-}^{\#2} + \alpha$	$k^2 (2r_3 + r_5)$	0	0	0

Massive and massless spectra

Quadratic pole

Pole residue:	$-\frac{1}{r_3 (2r_3 + r_5) (r_3 + 2r_5)} > 0$
Polarisations:	2

(No massive particles)

Unitarity conditions

$$r_3 < 0 \ \&\& \ (r_5 < -\frac{r_3}{2} \parallel r_5 > -2r_3) \parallel r_3 > 0 \ \&\& \ -2r_3 < r_5 < -\frac{r_3}{2}$$