

# Particle spectrograph

## Wave operator and propagator

### Source constraints

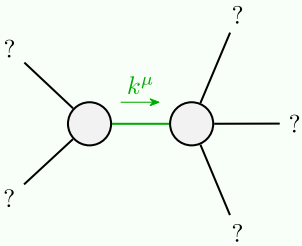
SO(3) irreps	Fundamental fields	Multiplicities
$\sigma_{0-}^{\#1} == 0$	$\epsilon \eta_{\alpha\beta\chi\delta} \partial^\delta \sigma^{\alpha\beta\chi} == 0$	1
$\sigma_{0+}^{\#1} == 0$	$\partial_\beta \sigma^{\alpha\beta}_\alpha == 0$	1
$\sigma_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} == 0$	3
$\sigma_{1+}^{\#2\alpha\beta} == 0$	$\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\beta\chi} == \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta}$	3
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	$3 \partial_\epsilon \partial_\delta \partial^\chi \partial^\alpha \sigma^{\beta\delta\epsilon} + 3 \partial_\epsilon \partial^\epsilon \partial^\chi \partial^\alpha \sigma^{\beta\delta}_\delta +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\chi\delta} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\delta\chi} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\beta\delta} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\beta\chi\alpha} +$ $3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\alpha \sigma^{\delta\epsilon}_\delta + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{\beta\delta\epsilon} +$ $3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\alpha \sigma^{\alpha\delta}_\delta == 3 \partial_\epsilon \partial_\delta \partial^\chi \partial^\beta \sigma^{\alpha\delta\epsilon} +$ $3 \partial_\epsilon \partial^\epsilon \partial^\chi \partial^\beta \sigma^{\alpha\delta}_\delta + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\chi\delta} +$ $4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\beta\delta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\alpha \sigma^{\chi\delta\beta} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\chi \sigma^{\beta\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\alpha\beta\chi} +$ $2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\alpha\chi\beta} + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\beta \sigma^{\delta\epsilon}_\delta +$ $3 \eta^{\beta\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial_\delta \sigma^{\alpha\delta\epsilon} + 3 \eta^{\alpha\chi} \partial_\phi \partial^\phi \partial_\epsilon \partial^\delta \sigma^{\beta\delta}_\delta$	5
Total constraints/gauge generators:		13

### Quadratic (free) action

$$S == \iiint \left( \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - \frac{1}{2} r_3 (\partial_\beta \omega_{,\theta} \partial' \omega_{\beta}^{\alpha\beta} + \partial' \omega_{\beta}^{\theta} \partial' \omega_{\theta}^{\alpha\beta} + \partial_\alpha \omega^{\alpha\beta\iota} \partial_\theta \omega_{\beta,\iota} - 2 \partial' \omega_{\beta,\iota}^{\alpha\beta} \partial_\theta \omega_{\beta}^{\theta} + \partial_\alpha \omega^{\alpha\beta\iota} \partial_\theta \omega_{\iota}^{\theta} + 2 \partial' \omega_{\alpha}^{\alpha\beta} \partial_\theta \omega_{\iota,\beta}^{\theta} + 8 \partial_\beta \omega_{\iota\theta\alpha} \partial^\theta \omega^{\alpha\beta\iota}) + r_5 (\partial_\iota \omega_{\theta,\kappa} \partial^\theta \omega_{\kappa}^{\alpha\iota} - \partial_\theta \omega_{\iota,\kappa} \partial^\theta \omega_{\kappa}^{\alpha\iota} - (\partial_\alpha \omega^{\alpha\iota\theta} - 2 \partial^\theta \omega^{\alpha\iota}_\alpha) (\partial_\kappa \omega_{\iota,\theta}^{\kappa} - \partial_\kappa \omega_{\theta,\iota}^{\kappa})) \right) [t, x, y, z] dz dy dx dt$$

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

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