

Particle spectrograph

Wave operator and propagator

Source constraints		
SO(3) irreps	Fundamental fields	Multiplicities
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\sigma_{0+}^{\#1} == 0$	$\partial_\beta \sigma^{\alpha\beta}{}_\alpha == 0$	1
$\tau_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\alpha\beta}$	3
$\tau_{1-}^{\#1\alpha} == 0$	$\partial_\chi \partial_\beta \partial^\alpha \tau^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau^{\beta\alpha}$	3
$\sigma_{1-}^{\#2\alpha} == 0$	$\partial_\chi \partial_\beta \sigma^{\alpha\beta\chi} == 0$	3
$\sigma_{1-}^{\#1\alpha} == 0$	$\partial_\chi \partial^\alpha \sigma^{\beta\chi}{}_\beta + \partial_\chi \partial^\chi \sigma^\alpha{}_\beta{}^\beta == \partial_\chi \partial_\beta \sigma^{\alpha\beta\chi}$	3
$\tau_{1+}^{\#1\alpha\beta} == 0$	$\partial_\chi \partial^\alpha \tau^{\beta\chi} + \partial_\chi \partial^\beta \tau^{\chi\alpha} + \partial_\chi \partial^\chi \tau^{\alpha\beta} == \partial_\chi \partial^\alpha \tau^{\chi\beta} + \partial_\chi \partial^\beta \tau^{\alpha\chi} + \partial_\chi \partial^\chi \tau^{\beta\alpha}$	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
$\sigma_{1+}^{\#1\alpha\beta} == 0$	$\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} == \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}$	3
$\sigma_{2+}^{\#1\alpha\beta} == 0$	$2\partial_\delta \partial^\beta \partial^\alpha \sigma^{\chi\delta}{}_\chi + 3(\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha}) == 3\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3\partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 2\eta^{\alpha\beta}\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}{}_\chi$	5
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	$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 \sigma^{\alpha\chi\delta} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta\alpha} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta\chi} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta\chi} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\alpha} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\beta\chi} + 2\partial_\epsilon \partial^\epsilon \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^\alpha \sigma^{\delta\epsilon}{}_\delta == 3\partial_\epsilon \partial_\delta \partial^\chi \partial^\beta \sigma^{\alpha\delta\epsilon} + 3\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\delta}{}_\delta + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\chi\delta} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\chi} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\chi\delta} + 2\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\beta\delta\alpha} + 4\partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\alpha\beta\chi} + 2\partial_\epsilon \partial^\epsilon \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^\alpha \sigma^{\delta\epsilon}{}_\delta + 3\eta^{\alpha\chi}\partial_\phi \partial^\phi \partial_\epsilon \partial^\beta \sigma^{\delta\epsilon}{}_\delta$	5
Total constraints/gauge generators:		33

Quadratic (free) action

$$S == \iiint \big(f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \beta_1 (-4 \omega^{\chi}{}_{\chi} \partial_\rho f^{\alpha\beta} + 4 \partial_\beta \omega^{\alpha\beta}{}_{\alpha} + 4 \omega^{\chi}{}_{\beta} \partial^\beta f^{\alpha}{}_{\alpha} - 2 \partial_\beta f^{\chi}{}_{\chi} \partial^\beta f^{\alpha}{}_{\alpha} - 2 \partial_\beta f^{\alpha\beta} \partial_\chi f^{\chi}{}_{\alpha} + 4 \partial^\beta f^{\alpha}{}_{\alpha} \partial_\chi f^{\chi}{}_{\beta} - 4 f^{\alpha\beta} (\partial_\beta \omega^{\chi}{}_{\chi} - \partial_\chi \omega^{\chi}{}_{\alpha}{}_{\beta}) - 4 f^{\alpha}{}_{\alpha} \partial_\chi \omega^{\beta\chi}{}_{\beta} + 4 \omega_{\alpha\chi\beta} \partial^\chi f^{\alpha\beta} - 2 \partial_\alpha f_{\beta\chi} \partial^\chi f^{\alpha\beta} - \partial_\alpha f_{\chi\beta} \partial^\chi f^{\alpha\beta} + \partial_\beta f_{\alpha\chi} \partial^\chi f^{\alpha\beta} + \partial_\chi f_{\alpha\beta} \partial^\chi f^{\alpha\beta} + \partial_\chi f_{\beta\alpha} \partial^\chi f^{\alpha\beta} \big) + \frac{1}{3} \alpha_3 (4 \partial_\beta \omega_{\alpha\chi\delta} - 2 \partial_\beta \omega_{\alpha\delta\chi} + 2 \partial_\beta \omega_{\chi\delta\alpha} - \partial_\chi \omega_{\alpha\beta\delta} + \partial_\delta \omega_{\alpha\beta\chi} - 2 \partial_\delta \omega_{\alpha\chi\beta}) \partial^\delta \omega^{\alpha\beta\chi} \big) [t, x, y, z] dz dy dx dt$$

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

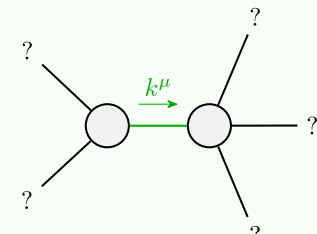
$\sigma_{1+}^{\#1} + \alpha\beta$	$\sigma_{1+}^{\#2} + \alpha\beta$	$\tau_{1+}^{\#1} + \alpha\beta$	$\sigma_{1-}^{\#1} - \alpha$	$\sigma_{1-}^{\#2} - \alpha$	$\tau_{1-}^{\#1} - \alpha$	$\tau_{1-}^{\#2}$
0	0	0	0	0	0	0
$\sigma_{1+}^{\#2} + \alpha\beta$	0	0	0	0	0	0
$\tau_{1+}^{\#1} + \alpha\beta$	0	0	0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

$\sigma_{2+}^{\#1} + \alpha\beta$	$\tau_{2+}^{\#1} + \alpha\beta$	$\sigma_{2-}^{\#1} - \alpha\beta\chi$
0	0	0
$\tau_{2+}^{\#1} + \alpha\beta$	0	$\frac{1}{2\beta_1 k^2}$
$\sigma_{2-}^{\#1} + \alpha\beta\chi$	0	0

$\omega_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#2}$	$\omega_{0-}^{\#1} - \alpha$
0	0	0	0
$f_{0+}^{\#1} + \alpha\beta$	-4 $\beta_1 k^2$	0	0
$f_{0+}^{\#2}$	0	0	0
$\omega_{0-}^{\#1} - \alpha$	0	0	$\alpha_3 k^2$

$\omega_{2+}^{\#1} + \alpha\beta$	$f_{2+}^{\#1} + \alpha\beta$	$\omega_{2-}^{\#1} - \alpha\beta\chi$
0	0	0
$f_{2+}^{\#1} + \alpha\beta$	0	2 $\beta_1 k^2$
$\omega_{2-}^{\#1} - \alpha\beta\chi$	0	0

Massive and massless spectra



Quadratic pole

Pole residue: $\frac{1}{\beta_1} > 0$

Polarisations: 2

(No massive particles)

Unitarity conditions

$\beta_1 > 0$