

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
$\tau_{0+}^{\#2} == 0$	$\partial_\beta \partial_\alpha \tau^{\alpha\beta} == 0$	1
$\sigma_{0+}^{\#1} == 0$	$\partial_\beta \sigma^\alpha{}_\beta == 0$	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
$\sigma_{2-}^{\#1\alpha\beta\chi} == 0$	$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^{\alpha\delta\delta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\beta\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\beta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\alpha\chi\beta} + 3 \eta^{\alpha\chi} \partial_\delta \partial^\phi \partial_\epsilon \partial^\beta \sigma^{\delta\epsilon}{}_\delta + 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^\beta \sigma^{\alpha\delta}{}_\delta + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\chi\delta\beta} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\beta\delta\alpha} + 4 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\beta \sigma^{\alpha\beta\chi} + 2 \partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \sigma^{\alpha\chi\beta} + 3 \eta^{\alpha\chi} \partial_\delta \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_\delta \partial^\phi \partial_\epsilon \partial^\beta \sigma^{\delta\epsilon}{}_\delta$	5
$\sigma_{2+}^{\#1\alpha\beta} == 0$	$3 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\beta\chi\delta} + 3 \partial_\delta \partial_\chi \partial^\beta \sigma^{\alpha\chi\delta} + 2 \eta^{\alpha\beta} \partial_\epsilon \partial^\epsilon \partial_\delta \sigma^{\chi\delta}{}_\chi == 2 \partial_\delta \partial^\beta \partial^\alpha \sigma^{\chi\delta}{}_\chi + 3 (\partial_\delta \partial^\delta \partial_\chi \sigma^{\alpha\chi\beta} + \partial_\delta \partial^\delta \partial_\chi \sigma^{\beta\chi\alpha})$	5
Total constraints/gauge generators:		34

Quadratic (free) action

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$$\begin{aligned} &\iiint (f^{\alpha\beta}{}_\tau \tau_{\alpha\beta} + \omega^{\alpha\beta\chi}{}_\sigma \sigma_{\alpha\beta\chi} + \tfrac{1}{2} \lambda (-4 \omega_\alpha{}_\theta \omega_\theta{}_\alpha \partial_\iota f^{\alpha\iota}{}_\alpha + 4 \partial_\iota \omega_\iota{}_\alpha \omega^\alpha{}_\theta \partial^\iota f^\alpha{}_\alpha - 2 \partial_\iota f^\theta{}_\theta \partial^\iota f^\alpha{}_\alpha - 2 \partial_\iota f^{\alpha\iota}{}_\theta \partial_\theta f^\theta{}_\alpha + 4 \partial^\iota f^\alpha{}_\alpha \partial_\theta f^\theta{}_\iota - \\ &4 f^{\alpha\iota}{}_\theta (\partial_\iota \omega_\alpha{}_\theta - \partial_\theta \omega_\alpha{}_\iota) - 4 f^\alpha{}_\alpha \partial_\theta \omega^\iota{}_\theta + 4 \omega_{\alpha\theta\iota} \partial^\theta f^{\alpha\iota}{}_\alpha - \\ &2 \partial_\alpha f_{\iota\theta} \partial^\theta f^{\alpha\iota}{}_\alpha - \partial_\alpha f_{\theta\iota} \partial^\theta f^{\alpha\iota}{}_\alpha + \partial_\iota f_{\alpha\theta} \partial^\theta f^{\alpha\iota}{}_\alpha + \\ &\partial_\theta f_{\alpha\iota} \partial^\theta f^{\alpha\iota}{}_\alpha + \partial_\theta f_{\iota\alpha} \partial^\theta f^{\alpha\iota}{}_\alpha)) [t, x, y, z] dz dy dx dt \end{aligned}$$

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

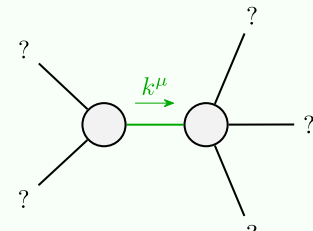
$\omega_{2+}^{\#1} + \alpha\beta$	$f_{2+}^{\#1} + \alpha\beta$	$\omega_{2-}^{\#1} + \alpha\beta\chi$
0	0	0
0	$k^2 \lambda$	0
0	0	0

$\omega_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#1} + \alpha\beta$	$f_{0+}^{\#2} + \alpha\beta$	$\omega_0^{\#1} + \alpha\beta\chi$
0	0	0	0
0	$-2k^2 \lambda$	0	0
0	0	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
0	$\frac{1}{k^2 \lambda}$	0
0	0	0

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

Massive and massless spectra



Quadratic pole
Pole residue: $\frac{1}{\lambda} > 0$
Polarisations: 2

(No massive particles)

Unitarity conditions

$\lambda > 0$