

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

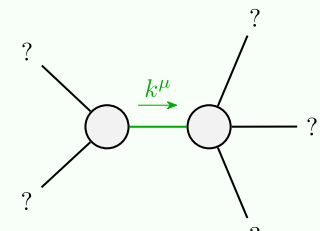
Quadratic (free) action

S ==

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

$\mathcal{A}_{1+}^{\#1} + \alpha\beta$	$\mathcal{A}_{1+}^{\#2}$	$\mathcal{A}_{1+}^{\#1} + \alpha\beta$	$f_{1+}^{\#1} + \alpha\beta$	$\mathcal{A}_{1-}^{\#1}$	$\mathcal{A}_{1-}^{\#2}$	$\mathcal{A}_{1-}^{\#1}$	$f_{1-}^{\#1}$	$f_{1-}^{\#2}$	α
0	0	0	0	0	0	0	0	0	0
$\mathcal{A}_{1+}^{\#2} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$f_{1+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$\mathcal{A}_{1-}^{\#1} + \alpha$	0	0	0	0	0	0	0	0	0
$\mathcal{A}_{1-}^{\#2} + \alpha$	0	0	0	0	0	0	0	0	0
$f_{1-}^{\#1} + \alpha$	0	0	0	0	0	0	0	0	0
$f_{1-}^{\#2} + \alpha$	0	0	0	0	0	0	0	0	0
$\sigma_{1+}^{\#1} + \alpha\beta$	$\sigma_{1+}^{\#2}$	$\sigma_{1+}^{\#1} + \alpha\beta$	$\tau_{1+}^{\#1} + \alpha\beta$	$\sigma_{1-}^{\#1}$	$\sigma_{1-}^{\#2}$	$\sigma_{1-}^{\#1}$	$\tau_{1-}^{\#1}$	$\tau_{1-}^{\#2}$	α
$\sigma_{1+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$\sigma_{1+}^{\#2} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$\tau_{1+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$\sigma_{1-}^{\#1} + \alpha$	0	0	0	0	0	0	0	0	0
$\sigma_{1-}^{\#2} + \alpha$	0	0	0	0	0	0	0	0	0
$\tau_{1-}^{\#1} + \alpha$	0	0	0	0	0	0	0	0	0
$\tau_{1-}^{\#2} + \alpha$	0	0	0	0	0	0	0	0	0
$\sigma_{0+}^{\#1} +$	$\sigma_{0+}^{\#2}$	$\tau_{0+}^{\#1} +$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$	$\sigma_{0-}^{\#2}$	$\tau_{0-}^{\#1}$	$\tau_{0-}^{\#2}$	$\sigma_{0-}^{\#1}$	
$\sigma_{0+}^{\#1} +$	0	0	0	0	0	0	0	0	0
$\tau_{0+}^{\#1} +$	0	$-\frac{1}{2k^2\lambda}$	0	0	0	0	0	0	0
$\tau_{0+}^{\#2} +$	0	0	0	0	0	0	0	0	0
$\sigma_{0-}^{\#1} +$	0	0	0	0	0	0	0	0	0
$\mathcal{A}_{2+}^{\#1} + \alpha\beta$	$\mathcal{A}_{2+}^{\#2}$	$\mathcal{A}_{2+}^{\#1} + \alpha\beta$	$f_{2+}^{\#1} + \alpha\beta$	$\mathcal{A}_{2-}^{\#1}$	$\mathcal{A}_{2-}^{\#2}$	$\mathcal{A}_{2-}^{\#1}$	$f_{2-}^{\#1}$	$f_{2-}^{\#2}$	$\alpha\beta\chi$
$\mathcal{A}_{2+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$f_{2+}^{\#1} + \alpha\beta$	0	$k^2\lambda$	0	0	0	0	0	0	0
$\mathcal{A}_{2-}^{\#1} + \alpha\beta\chi$	0	0	0	0	0	0	0	0	0
$\mathcal{A}_{0+}^{\#1} +$	$\mathcal{A}_{0+}^{\#2}$	$f_{0+}^{\#1} +$	$f_{0+}^{\#2}$	$\mathcal{A}_{0-}^{\#1}$	$\mathcal{A}_{0-}^{\#2}$	$f_{0-}^{\#1}$	$f_{0-}^{\#2}$	$\sigma_{2-}^{\#1} + \alpha\beta\chi$	
$\mathcal{A}_{0+}^{\#1} +$	0	0	0	0	0	0	0	0	0
$f_{0+}^{\#1} +$	0	$-2k^2\lambda$	0	0	0	0	0	0	0
$f_{0+}^{\#2} +$	0	0	0	0	0	0	0	0	0
$\mathcal{A}_{0-}^{\#1} +$	0	0	0	0	0	0	0	0	0
$\sigma_{2+}^{\#1} + \alpha\beta$	$\sigma_{2+}^{\#2}$	$\tau_{2+}^{\#1} + \alpha\beta$	$\tau_{2+}^{\#2}$	$\sigma_{2-}^{\#1} + \alpha\beta\chi$	$\sigma_{2-}^{\#2}$	$\tau_{2-}^{\#1} + \alpha\beta\chi$	$\tau_{2-}^{\#2}$	$\sigma_{2-}^{\#1} + \alpha\beta\chi$	
$\sigma_{2+}^{\#1} + \alpha\beta$	0	0	0	0	0	0	0	0	0
$\tau_{2+}^{\#1} + \alpha\beta$	0	$\frac{1}{k^2\lambda}$	0	0	0	0	0	0	0
$\sigma_{2-}^{\#1} + \alpha\beta\chi$	0	0	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

$\lambda > 0$