Particle spectrograph

Wave operator and propagator

Source constraints

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

Quadratic (free) action

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

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

$\sigma_{0^+}^{\#1}\dagger$	0	0	0	0
$\tau_{0^+}^{\#1}\dagger$	0	$-\frac{1}{4\,\beta_1\,k^2}$	0	0
$\tau_{0^+}^{\#2}\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\dagger$	0	0	0	$\frac{1}{\alpha_3\,k^2}$

$\mathcal{A}_{0^+}^{\#1}$ $f_{0^+}^{\#1}$ $f_{0^+}^{\#2}$ $\mathcal{A}_{0^-}^{\#1}$

$\mathcal{A}_{0^+}^{\#1}\dagger$	0	0	0	0
$f_{0^+}^{\#1}\dagger$	0	$-4\,\beta_1\,k^2$	0	0
$f_{0^+}^{\#2}\dagger$	0	0	0	0
$\mathcal{A}_{0^-}^{\#1}\dagger$	0	0	0	$\alpha_3\,k^2$

$\mathcal{A}_{2^+\,\alpha\beta}^{\#1}$ $f_{2^+\,\alpha\beta}^{\#1}$ $\mathcal{A}_{2^-\,\alpha\beta\chi}^{\#1}$

$\mathcal{A}_{2^+}^{\#1\,\alpha\beta}\dagger$	0	0	0
$f_{2^+}^{\#1\,\alpha\beta}\dagger$	0	$2\,\beta_1\,k^2$	0
$\mathcal{A}_{2^-}^{\#1\,\alpha\beta\chi}\dagger$	0	0	0

$\mathcal{A}_{1^+\,\alpha\beta}^{\#1}$ $\mathcal{A}_{1^+\,\alpha\beta}^{\#2}$ $f_{1^+\,\alpha\beta}^{\#1}$ $\mathcal{A}_{1^-\,\alpha}^{\#1}$ $\mathcal{A}_{1^-\,\alpha}^{\#2}$ $f_{1^-\,\alpha}^{\#1}$ $f_{1^-\,\alpha}^{\#2}$

$\mathcal{A}_{1^+}^{\#1\,\alpha\beta}\dagger$	0	0	0	0	0	0	0
$\mathcal{A}_{1^+}^{\#2\,\alpha\beta}\dagger$	0	0	0	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\dagger$	0	0	0	0	0	0	0
$\mathcal{A}_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$\mathcal{A}_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	0	0	0	0
$f_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\dagger$	0	0	0	0	0	0	0

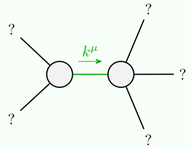
$\sigma_{1^+\,\alpha\beta}^{\#1}$ $\sigma_{1^+\,\alpha\beta}^{\#2}$ $\tau_{1^+\,\alpha\beta}^{\#1}$ $\sigma_{1^-\,\alpha}^{\#1}$ $\sigma_{1^-\,\alpha}^{\#2}$ $\tau_{1^-\,\alpha}^{\#1}$ $\tau_{1^-\,\alpha}^{\#2}$

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

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

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

Massive and massless spectra



Quadratic pole

Pole residue:	$\frac{1}{\beta_1} > 0$
Polarisations:	2

(No massive particles)

Unitarity conditions

$\beta_1 > 0$