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

Quadratic (free) action

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

$\omega_{1^+}^{\#1}{}_{\alpha\beta}\dagger$

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

$\sigma_{1^+}^{\#1}{}_{\alpha\beta}\dagger$

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

$\sigma_{2^+}^{\#1}{}_{\alpha\beta}\dagger$

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

$\sigma_{0^+}^{\#1}\dagger$

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

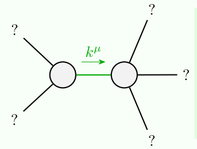
$\omega_{0^+}^{\#1}\dagger$

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

$\omega_{2^+}^{\#1}{}_{\alpha\beta}\dagger^{\alpha\beta}$

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

Massive and massless spectra



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

(No massive particles)

Unitarity conditions

$\beta_1 > 0$