Particle spectrograph

Wave operator and propagator

Quadratic (free) action

$$
\begin{aligned}
S_F = \int\int\int\Big(&\tfrac{1}{3}\,(-6\,\beta_1\,\omega_\alpha{}^{\chi\delta}\,\omega_{\chi\delta}{}^{\alpha}+3\,\omega_\alpha{}^{\chi}{}_{\chi}\,\partial_\beta f^{\alpha\beta}-6\,\beta_1\,\omega_{\alpha\,\chi}{}^{\chi}+12\,\beta_1\,\partial_\beta\omega^{\alpha\beta}{}_{\alpha}+2\,\alpha_3\,\partial^\alpha\omega^{\beta\zeta}{}_{\chi}\,\partial_\beta\omega_{\zeta\alpha}{}^{\chi}+\\
&\omega_\alpha{}^{\delta}{}_{\delta}\,\partial_\beta f^{\alpha\beta}-12\,\beta_1\,f^{\alpha\beta}\,\partial_\beta\omega_{\alpha\,\chi}{}^{\chi}+6\,\beta_1\,\partial_\beta f^{\chi}{}_{\chi}\,\partial^\beta f^{\alpha}{}_{\alpha}-6\,\beta_1\,\partial_\beta f^{\chi}{}_{\chi}\,\partial^\beta f^{\alpha}{}_{\alpha}+12\,\beta_1\,f^{\alpha\beta}\,\partial_\chi\omega_{\alpha\,\beta}{}^{\chi}-\\
&12\,\beta_1\,f^{\alpha}{}_{\alpha}\,\partial_\chi\omega^{\beta\chi}{}_{\beta}-2\,\alpha_3\,\partial_\beta\omega_{\zeta\alpha}{}^{\delta}\,\partial_\chi\omega_{\zeta\alpha}{}^{\chi}\,\partial_\chi\omega^{\beta\zeta\alpha}-\alpha_3\,\partial_\beta\omega_{\zeta\alpha}{}^{\chi}\,\partial_\chi\omega^{\zeta\alpha\beta}-\\
&6\,\beta_1\,\omega_{\alpha\chi\beta}\,(\omega^{\alpha\beta\chi}-2\,\partial^\chi f^{\alpha\beta})+3\,\beta_1\,\partial_\chi f_\beta{}^{\delta}\,\partial^\chi f_\delta{}^{\beta}+3\,\beta_1\,\partial_\chi f_\beta{}^{\delta}\,\partial^\chi f_\delta{}^{\beta}+\\
&2\,\alpha_3\,\partial_\chi\omega^{\beta\zeta\alpha}\,\partial^\chi\omega_{\zeta\alpha\beta}+\alpha_3\,\partial_\chi\omega^{\zeta\alpha\beta}\,\partial^\chi\omega_{\zeta\alpha\beta}+12\,\beta_1\,\partial^\beta f^\alpha{}_\alpha\,\partial_\delta f^\delta{}_\beta-\\
&6\,\beta_1\,\partial_\beta f_\chi{}^{\beta}\,\partial_\delta f^{\chi\delta}+2\,\alpha_3\,\partial^\beta\omega_\alpha{}^{\delta\zeta}\,\partial_\delta\omega_{\zeta\beta}{}^{\alpha}-2\,\alpha_3\,\partial^\beta\omega_\alpha{}^{\zeta\delta}\,\partial_\delta\omega_{\zeta\beta}{}^{\alpha}-3\,\beta_1\,\partial^\chi f_\zeta{}^{\beta}\,\partial^\zeta f_{\beta\chi}-\\
&3\,\beta_1\,\partial^\chi f_\zeta{}^{\beta}\,\partial^\zeta f_{\chi\beta}+3\,\beta_1\,\partial^\chi f_{\delta\zeta}\,\partial^\zeta f^{\delta}{}_{\chi}-3\,\beta_1\,\partial^\chi f_{\zeta\delta}\,\partial^\zeta f^{\delta}{}_{\chi}\Big)[t,\,x,\,y,\,z]\,\mathrm{d}z\,\mathrm{d}y\,\mathrm{d}x\,\mathrm{d}t
\end{aligned}
$$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\sigma_{1^-}^{\#2\,\alpha} == 0$	3
$\sigma_{1^-}^{\#1\,\alpha} == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} == 0$	3
$\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	3
$\sigma_{1^+}^{\#1\,\alpha\beta} == 0$	3
$\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	5
$\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$	5
Total constraints:	33

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

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

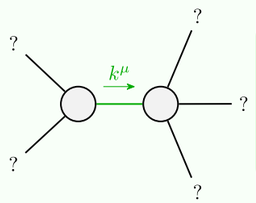
	$\omega_{2^+\,\alpha\beta}^{\#1}$	$f_{2^+\,\alpha\beta}^{\#1}$	$\omega_{2^-\,\alpha\beta\chi}^{\#1}$
$\omega_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	0	0	0
$f_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	0	$2\,\beta_1\,k^2$	0
$\omega_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	0

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

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

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

Massive and massless spectra



Quadratic pole

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

(No massive particles)

Unitarity conditions

$\beta_1 > 0$