Particle spectrograph

Wave operator and propagator

Quadratic (free) Lagrangian density

$$\frac{2}{3} t_2\, \omega_{\iota}{}^{\kappa\lambda}\, \omega_{\kappa\lambda}{}' + \frac{1}{3} t_2\, \omega_{\kappa\lambda}{}'\, \omega^{\kappa\lambda} + f^{\alpha\beta}\, \tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\, \sigma_{\alpha\beta\chi} + 2\, r_1\, \partial_\iota \omega^{\kappa\lambda}\, \partial' \omega_\lambda{}^\alpha{}_\kappa -$$
$$\frac{2}{3} r_1\, \partial^\beta \omega^{\theta\alpha}{}_\kappa\, \partial_\theta \omega_{\alpha\beta}{}^\kappa + \frac{2}{3} r_2\, \partial^\beta \omega^{\theta\alpha}{}_\kappa\, \partial_\theta \omega_{\alpha\beta}{}^\kappa - \frac{2}{3} r_1\, \partial_\theta \omega_{\alpha\beta}{}^\kappa\, \partial_\kappa \omega^{\alpha\beta\theta} -$$
$$\frac{1}{3} r_2\, \partial_\theta \omega_{\alpha\beta}{}^\kappa\, \partial_\kappa \omega^{\alpha\beta\theta} + \frac{2}{3} r_1\, \partial_\theta \omega_{\alpha\beta}{}^\kappa\, \partial_\kappa \omega^{\theta\alpha\beta} - \frac{2}{3} r_2\, \partial_\theta \omega_{\alpha\beta}{}^\kappa\, \partial_\kappa \omega^{\theta\alpha\beta} -$$
$$2\, r_1\, \partial_\alpha \omega_\lambda{}^\alpha{}_\theta\, \partial_\kappa \omega^{\theta\kappa\lambda} + 4\, r_3\, \partial_\alpha \omega_\lambda{}^\alpha{}_\theta\, \partial_\kappa \omega^{\theta\kappa\lambda} + 2\, r_1\, \partial_\theta \omega_\lambda{}^\alpha{}_\alpha\, \partial_\kappa \omega^{\theta\kappa\lambda} -$$
$$4\, r_3\, \partial_\theta \omega_\lambda{}^\alpha{}_\alpha\, \partial_\kappa \omega^{\theta\kappa\lambda} + 2\, r_1\, \partial_\alpha \omega_\lambda{}^\alpha{}_\theta\, \partial_\kappa \omega^{\kappa\lambda\theta} - 4\, r_1\, \partial_\theta \omega_\lambda{}^\alpha{}_\alpha\, \partial_\kappa \omega^{\kappa\lambda\theta} +$$
$$\frac{1}{6} t_2\, \partial^\alpha f_{\theta\kappa}\, \partial^\kappa f_\alpha{}^\theta - \frac{1}{6} t_2\, \partial^\alpha f_{\kappa\theta}\, \partial^\kappa f_\alpha{}^\theta + \frac{1}{6} t_2\, \partial^\alpha f_\kappa{}^\lambda\, \partial^\kappa f_{\alpha\lambda} + \frac{1}{3} t_2\, \omega_{\iota\theta\kappa}\, \partial^\kappa f'^{\iota\theta} -$$
$$\frac{2}{3} t_2\, \omega_{\iota\kappa\theta}\, \partial^\kappa f'^{\iota\theta} - \frac{1}{3} t_2\, \omega_{\theta\iota\kappa}\, \partial^\kappa f'^{\iota\theta} + \frac{2}{3} t_2\, \omega_{\theta\kappa\iota}\, \partial^\kappa f'^{\iota\theta} - \frac{1}{6} t_2\, \partial^\alpha f^\lambda{}_\kappa\, \partial^\kappa f_{\lambda\alpha} -$$
$$\frac{1}{6} t_2\, \partial_\kappa f^\lambda{}_\theta\, \partial^\kappa f_\lambda{}^\theta + \frac{2}{3} r_1\, \partial_\kappa \omega^{\alpha\beta\theta}\, \partial^\kappa \omega_{\alpha\beta\theta} +$$
$$\frac{1}{3} r_2\, \partial_\kappa \omega^{\alpha\beta\theta}\, \partial^\kappa \omega_{\alpha\beta\theta} - \frac{2}{3} r_1\, \partial_\kappa \omega^{\theta\alpha\beta}\, \partial^\kappa \omega_{\alpha\beta\theta} + \frac{2}{3} r_2\, \partial_\kappa \omega^{\theta\alpha\beta}\, \partial^\kappa \omega_{\alpha\beta\theta} +$$
$$\frac{2}{3} r_1\, \partial^\beta \omega_\iota{}^{\alpha\lambda}\, \partial_\lambda \omega_{\alpha\beta}{}' - \frac{2}{3} r_2\, \partial^\beta \omega_\iota{}^{\alpha\lambda}\, \partial_\lambda \omega_{\alpha\beta}{}' + \frac{4}{3} r_1\, \partial^\beta \omega_\iota{}^{\lambda\alpha}\, \partial_\lambda \omega_{\alpha\beta}{}' +$$
$$\frac{2}{3} r_2\, \partial^\beta \omega_\iota{}^{\lambda\alpha}\, \partial_\lambda \omega_{\alpha\beta}{}' - 4\, r_3\, \partial^\beta \omega_\iota{}^{\lambda\alpha}\, \partial_\lambda \omega_{\alpha\beta}{}' + 2\, r_1\, \partial_\alpha \omega_\lambda{}^\alpha{}_\theta\, \partial^\lambda \omega^{\theta\kappa}{}_\kappa -$$
$$4\, r_3\, \partial_\alpha \omega_\lambda{}^\alpha{}_\theta\, \partial^\lambda \omega^{\theta\kappa}{}_\kappa - 2\, r_1\, \partial_\theta \omega_\lambda{}^\alpha{}_\alpha\, \partial^\lambda \omega^{\theta\kappa}{}_\kappa + 4\, r_3\, \partial_\theta \omega_\lambda{}^\alpha{}_\alpha\, \partial^\lambda \omega^{\theta\kappa}{}_\kappa$$

	$\omega_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^+}^{\#2\,\alpha\beta}$	$f_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^-}^{\#1\,\alpha}$	$\omega_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{2 t_2}{3}$	$\frac{\sqrt{2}\, t_2}{3}$	$\frac{1}{3} i \sqrt{2}\, k t_2$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{\sqrt{2}\, t_2}{3}$	$\frac{t_2}{3}$	$\frac{i k t_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$-\frac{1}{3} i \sqrt{2}\, k t_2$	$-\frac{1}{3} i k t_2$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	$-k^2 r_1$	0	0	0
$\omega_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0

	$\sigma_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#2\,\alpha\beta}$	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\sigma_{1^-}^{\#2\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{6}{(3+k^2)^2 t_2}$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$-\frac{3 i \sqrt{2}\, k}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\alpha\beta}\,\dagger^{\alpha\beta}$	$\frac{3\sqrt{2}}{(3+k^2)^2 t_2}$	$\frac{3}{(3+k^2)^2 t_2}$	$-\frac{3 i k}{(3+k^2)^2 t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	$-\frac{3 i \sqrt{2}\, k}{(3+k^2)^2 t_2}$	$-\frac{3 i k}{(3+k^2)^2 t_2}$	$\frac{3 k^2}{(3+k^2)^2 t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	$-\frac{1}{k^2 r_1}$	0	0	0
$\tau_{1^-}^{\#1\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\,\dagger^{\alpha}$	0	0	0	0	0	0	0

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$6 k^2 (-r_1 + r_3)$	0	0	0
$f_{0^+}^{\#1}\,\dagger$	0	0	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	$k^2 r_2 + t_2$

Source constraints/gauge generators

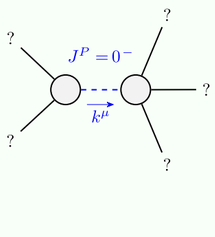
SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\sigma_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i k\, \sigma_{1^+}^{\#1\,\alpha\beta} == 0$	3
$\sigma_{1^+}^{\#1\,\alpha\beta} == \sigma_{1^+}^{\#2\,\alpha\beta}$	3
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	5
$\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	27

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\,\dagger$	$\frac{1}{6 k^2 (-r_1 + r_3)}$	0	0	0
$\tau_{0^+}^{\#1}\,\dagger$	0	0	0	0
$\tau_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\,\dagger$	0	0	0	$\frac{1}{k^2 r_2 + t_2}$

	$\sigma_{2^+\,\alpha\beta}^{\#1}$	$\tau_{2^+\,\alpha\beta}^{\#1}$	$\sigma_{2^-\,\alpha\beta\chi}^{\#1}$
$\sigma_{2^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	0	0	0
$\tau_{2^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	0	0	0
$\sigma_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	$\frac{1}{k^2 r_1}$

	$\omega_{2^+\,\alpha\beta}^{\#1}$	$f_{2^+\,\alpha\beta}^{\#1}$	$\omega_{2^-\,\alpha\beta\chi}^{\#1}$
$\omega_{2^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	0	0	0
$f_{2^+}^{\#1\,\alpha\beta}\,\dagger^{\alpha\beta}$	0	0	0
$\omega_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	$k^2 r_1$

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_2 < 0 \;\&\&\; t_2 > 0$