Particle spectrograph

Lagrangian density

$$-\frac{1}{2}\,\alpha_0\,\omega_{\alpha\chi\beta}\,\omega^{\alpha\beta\chi}-\frac{1}{2}\,\alpha_0\,\omega^{\alpha\beta}{}_{\alpha}\,\omega_{\beta}{}^{\chi}{}_{\chi}+2\,\beta_1\,\omega^{\alpha\beta}{}_{\alpha}\,\omega_{\beta}{}^{\chi}{}_{\chi}-2\,\beta_1\,\omega_{\alpha}{}^{\chi\delta}\,\omega_{\chi\delta}{}^{\alpha}-2\,\beta_1\,\omega_{\alpha}{}^{\chi}{}_{\chi}\,\partial_{\beta}f^{\alpha\beta}-$$
$$2\,\beta_1\,\omega_{\alpha}{}^{\delta}{}_{\delta}\,\partial_{\beta}f^{\alpha\beta}-\alpha_0\,f^{\alpha\beta}\,\partial_{\beta}\omega_{\alpha}{}^{\chi}{}_{\chi}+\alpha_0\,\partial_{\beta}\omega^{\alpha\beta}{}_{\alpha}+2\,\beta_1\,\omega_{\beta}{}^{\chi}{}_{\chi}\,\partial^{\beta}f^{\alpha}{}_{\alpha}+2\,\beta_1\,\omega_{\beta}{}^{\delta}{}_{\delta}\,\partial^{\beta}f^{\alpha}{}_{\alpha}-2\,\beta_1\,\partial_{\beta}f^{\chi}{}_{\chi}\,\partial^{\beta}f^{\alpha}{}_{\alpha}+$$
$$\alpha_0\,f^{\alpha\beta}\,\partial_{\chi}\omega_{\alpha}{}^{\chi}{}_{\beta}-\alpha_0\,f^{\alpha}{}_{\alpha}\,\partial_{\chi}\omega^{\beta\chi}{}_{\beta}+4\,\beta_1\,\omega_{\alpha\chi\beta}\,\partial^{\chi}f^{\alpha\beta}+\beta_1\,\partial_{\chi}f_{\beta}{}^{\delta}\,\partial^{\chi}f_{\delta}{}^{\beta}+\beta_1\,\partial_{\chi}f^{\delta}{}_{\beta}\,\partial^{\chi}f_{\delta}{}^{\beta}+4\,\beta_1\,\partial^{\beta}f^{\alpha}{}_{\alpha}\,\partial_{\delta}f_{\beta}{}^{\delta}-$$
$$2\,\beta_1\,\partial_{\beta}f_{\chi}{}^{\beta}\,\partial_{\delta}f^{\chi\delta}+\frac{2}{3}\,\alpha_6\,\partial_{\beta}\omega^{\alpha\beta}{}_{\alpha}\,\partial_{\delta}\omega^{\chi\delta}{}_{\chi}-\beta_1\,\partial^{\chi}f_{\zeta}{}^{\beta}\,\partial^{\zeta}f_{\beta\chi}-\beta_1\,\partial^{\chi}f_{\zeta}{}^{\beta}\,\partial^{\zeta}f_{\chi\beta}+\beta_1\,\partial^{\chi}f_{\delta\zeta}\,\partial^{\zeta}f^{\delta}{}_{\chi}-\beta_1\,\partial^{\chi}f_{\zeta\delta}\,\partial^{\zeta}f^{\delta}{}_{\chi}$$

Added source term: $f^{\alpha\beta}\,\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}$

Wave operator

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	$\frac{\alpha_0}{2}-2\,\beta_1+\alpha_6\,k^2$	$-\frac{i\,(\alpha_0-4\,\beta_1)\,k}{\sqrt{2}}$	0	0
$f_{0^+}^{\#1}\,\dagger$	$\frac{i\,(\alpha_0-4\,\beta_1)\,k}{\sqrt{2}}$	$-4\,\beta_1\,k^2$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	$\frac{1}{2}\,(\alpha_0-4\,\beta_1)$

	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^+}^{\#1}\,\dagger^{\alpha\beta}$	$\frac{1}{4}\,(\alpha_0-4\,\beta_1)$	$\frac{\alpha_0-4\,\beta_1}{2\,\sqrt{2}}$	$\frac{i\,(\alpha_0-4\,\beta_1)\,k}{2\,\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2}\,\dagger^{\alpha\beta}$	$\frac{\alpha_0-4\,\beta_1}{2\,\sqrt{2}}$	0	0	0	0	0	0
$f_{1^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{i\,(\alpha_0-4\,\beta_1)\,k}{2\,\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1^-}^{\#1}\,\dagger^{\alpha}$	0	0	0	$\frac{1}{4}\,(\alpha_0-4\,\beta_1)$	$-\frac{\alpha_0-4\,\beta_1}{2\,\sqrt{2}}$	0	$-\frac{1}{2}\,i\,(\alpha_0-4\,\beta_1)\,k$
$\omega_{1^-}^{\#2}\,\dagger^{\alpha}$	0	0	0	$-\frac{\alpha_0-4\,\beta_1}{2\,\sqrt{2}}$	0	0	0
$f_{1^-}^{\#1}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2}\,\dagger^{\alpha}$	0	0	0	$\frac{1}{2}\,i\,(\alpha_0-4\,\beta_1)\,k$	0	0	0

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{\alpha_0}{4}+\beta_1$	$\frac{i\,(\alpha_0-4\,\beta_1)\,k}{2\,\sqrt{2}}$	0
$f_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{i\,(\alpha_0-4\,\beta_1)\,k}{2\,\sqrt{2}}$	$2\,\beta_1\,k^2$	0
$\omega_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	$-\frac{\alpha_0}{4}+\beta_1$

Saturated propagator

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\,\dagger$	$\frac{8\,\beta_1}{{\alpha_0}^2-4\,\alpha_0\,\beta_1+8\,\alpha_6\,\beta_1\,k^2}$	$-\frac{i\,\sqrt{2}\,(\alpha_0-4\,\beta_1)}{\alpha_0\,(\alpha_0-4\,\beta_1)\,k+8\,\alpha_6\,\beta_1\,k^3}$	0	0
$\tau_{0^+}^{\#1}\,\dagger$	$\frac{i\,\sqrt{2}\,(\alpha_0-4\,\beta_1)}{\alpha_0\,(\alpha_0-4\,\beta_1)\,k+8\,\alpha_6\,\beta_1\,k^3}$	$-\frac{\alpha_0-4\,\beta_1+2\,\alpha_6\,k^2}{k^2\,({\alpha_0}^2-4\,\alpha_0\,\beta_1+8\,\alpha_6\,\beta_1\,k^2)}$	0	0
$\tau_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\,\dagger$	0	0	0	$\frac{2}{\alpha_0-4\,\beta_1}$

	$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
$\sigma_{1^+}^{\#1}\,\dagger^{\alpha\beta}$	0	$\frac{2\,\sqrt{2}}{(\alpha_0-4\,\beta_1)\,(1+k^2)}$	$\frac{2\,i\,\sqrt{2}\,k}{(\alpha_0-4\,\beta_1)\,(1+k^2)}$	0	0	0	0
$\sigma_{1^+}^{\#2}\,\dagger^{\alpha\beta}$	$\frac{2\,\sqrt{2}}{(\alpha_0-4\,\beta_1)\,(1+k^2)}$	$-\frac{2}{(\alpha_0-4\,\beta_1)\,(1+k^2)^2}$	$-\frac{2\,i\,k}{(\alpha_0-4\,\beta_1)\,(1+k^2)^2}$	0	0	0	0
$\tau_{1^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{2\,i\,\sqrt{2}\,k}{(\alpha_0-4\,\beta_1)\,(1+k^2)}$	$\frac{2\,i\,k}{(\alpha_0-4\,\beta_1)\,(1+k^2)^2}$	$-\frac{2\,k^2}{(\alpha_0-4\,\beta_1)\,(1+k^2)^2}$	0	0	0	0
$\sigma_{1^-}^{\#1}\,\dagger^{\alpha}$	0	0	0	0	$-\frac{2\,\sqrt{2}}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)}$	0	$-\frac{4\,i\,k}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)}$
$\sigma_{1^-}^{\#2}\,\dagger^{\alpha}$	0	0	0	$-\frac{2\,\sqrt{2}}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)}$	$-\frac{2}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)^2}$	0	$-\frac{2\,i\,\sqrt{2}\,k}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)^2}$
$\tau_{1^-}^{\#1}\,\dagger^{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#2}\,\dagger^{\alpha}$	0	0	0	$\frac{4\,i\,k}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)}$	$\frac{2\,i\,\sqrt{2}\,k}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)^2}$	0	$-\frac{4\,k^2}{(\alpha_0-4\,\beta_1)\,(1+2\,k^2)^2}$

	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{16\,\beta_1}{{\alpha_0}^2-4\,\alpha_0\,\beta_1}$	$\frac{2\,i\,\sqrt{2}}{\alpha_0\,k}$	0
$\tau_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{2\,i\,\sqrt{2}}{\alpha_0\,k}$	$\frac{2}{\alpha_0\,k^2}$	0
$\sigma_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	$\frac{1}{-\frac{\alpha_0}{4}+\beta_1}$

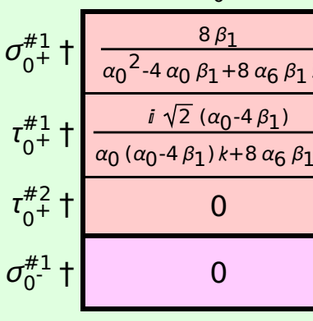
Source constraints

Source constraints

SO(3) irreps	#
$\tau_{0^+}^{\#2}==0$	1
$\tau_{1^-}^{\#2\,\alpha}+2\,i\,k\,\sigma_{1^-}^{\#2\,\alpha}==0$	3
$\tau_{1^-}^{\#1\,\alpha}==0$	3
$\tau_{1^+}^{\#1\,\alpha\beta}+i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta}==0$	3
Total #:	10

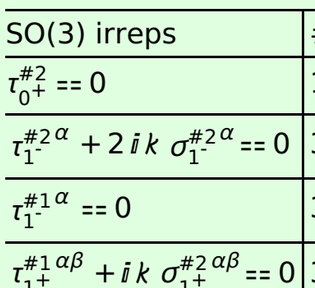
Massive spectrum

Massive particle



Pole residue:	$\frac{1}{\alpha_0}+\frac{1}{\alpha_6}-\frac{1}{4\,\beta_1}>0$
Polarisations:	1
Square mass:	$-\frac{\alpha_0\,(\alpha_0-4\,\beta_1)}{8\,\alpha_6\,\beta_1}>0$
Spin:	0
Parity:	Even

Massless spectrum



Quadratic pole

Pole residue:	$\frac{1}{\alpha_0}>0$
Polarisations:	2

Unitarity conditions

Unitarity conditions

$$\alpha_0>0\;\&\&\;\alpha_6>0\;\&\&\;\beta_1<0\;||\;\beta_1>\frac{\alpha_0}{4}$$