Particle spectrograph

Wave operator and propagator

$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
$\frac{\sqrt{2}\,(t_1-2t_2)}{3\,(1+k^2)\,t_1\,t_2}$	$\frac{i\sqrt{2}\,k\,(t_1-2t_2)}{3\,(1+k^2)\,t_1\,t_2}$	0	0	0	0
$\frac{t_1+4t_2}{3\,(1+k^2)^2\,t_1\,t_2}$	$\frac{ik\,(t_1+4t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$	0	0	0	0
$-\frac{ik\,(t_1+4t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$	$\frac{k^2\,(t_1+4t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$	0	0	0	0
0	0	$\frac{6}{(3+4k^2)^2\,t_1}$	$\frac{6\sqrt{2}}{(3+4k^2)^2\,t_1}$	0	$\frac{12\,i\,k}{(3+4k^2)^2\,t_1}$
0	0	$\frac{6\sqrt{2}}{(3+4k^2)^2\,t_1}$	$\frac{12}{(3+4k^2)^2\,t_1}$	0	$\frac{12\,i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$
0	0	0	0	0	0
0	0	$-\frac{12\,i\,k}{(3+4k^2)^2\,t_1}$	$-\frac{12\,i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$	0	$\frac{24k^2}{(3+4k^2)^2\,t_1}$

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

$\sigma_{1^+}^{\#1}{}_{\alpha\beta}\dagger^{\alpha\beta}$
$\frac{2\,(t_1+t_2)}{3\,t_1\,t_2}$
$\frac{\sqrt{2}\,(t_1-2t_2)}{3\,(1+k^2)\,t_1\,t_2}$
$-\frac{i\sqrt{2}\,k\,(t_1-2t_2)}{3\,(1+k^2)\,t_1\,t_2}$
0
0
0
0

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

$\sigma_{1^+}^{\#2}{}_{\alpha\beta}\dagger^{\alpha\beta}$
$\frac{\sqrt{2}\,(t_1-2t_2)}{3\,(1+k^2)\,t_1\,t_2}$
$\frac{t_1+4t_2}{3\,(1+k^2)^2\,t_1\,t_2}$
$-\frac{i\,k\,(t_1+4t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$
0
0
0
0

$\tau_{1^+}^{\#1}{}_{\alpha\beta}$

$\tau_{1^+}^{\#1}{}_{\alpha\beta}\dagger^{\alpha\beta}$
$\frac{i\sqrt{2}\,k\,(t_1-2t_2)}{3\,(1+k^2)\,t_1\,t_2}$
$\frac{ik\,(t_1+4t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$
$\frac{k^2\,(t_1+4t_2)}{3\,(1+k^2)^2\,t_1\,t_2}$
0
0
0
0

$\sigma_{1^-}^{\#1}{}_{\alpha}$

$\sigma_{1^-}^{\#1}{}_{\alpha}\dagger^{\alpha}$
0
0
0
$\frac{6}{(3+4k^2)^2\,t_1}$
$\frac{6\sqrt{2}}{(3+4k^2)^2\,t_1}$
$-\frac{12\,i\,k}{(3+4k^2)^2\,t_1}$
$-\frac{12\,i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$

$\sigma_{1^-}^{\#2}{}_{\alpha}$

$\sigma_{1^-}^{\#2}{}_{\alpha}\dagger^{\alpha}$
0
0
0
$\frac{6\sqrt{2}}{(3+4k^2)^2\,t_1}$
$\frac{12}{(3+4k^2)^2\,t_1}$
0
$\frac{12\,i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$

$\tau_{1^-}^{\#1}{}_{\alpha}$

$\tau_{1^-}^{\#1}{}_{\alpha}\dagger^{\alpha}$
0
0
0
0
0
0
0

$\tau_{1^-}^{\#2}{}_{\alpha}$

$\tau_{1^-}^{\#2}{}_{\alpha}\dagger^{\alpha}$
0
0
0
$\frac{12\,i\,k}{(3+4k^2)^2\,t_1}$
$\frac{12\,i\sqrt{2}\,k}{(3+4k^2)^2\,t_1}$
0
$\frac{24k^2}{(3+4k^2)^2\,t_1}$

Quadratic (free) action

$$S == \iiint\Big(\frac{1}{6}\,(2\,t_1\;\omega^{\alpha\prime}{}_{\alpha}\;\omega_{\prime}{}^{\theta}{}_{\theta}+6\;f^{\alpha\beta}\;\tau_{\alpha\beta}+6\;\omega^{\alpha\beta\chi}\;\sigma_{\alpha\beta\chi}-4\,t_1\;\omega_{\alpha}{}^{\theta}\;\partial_{\prime}f^{\alpha\prime}+4\,t_1\;\omega_{\prime}{}^{\theta}$$
$$\partial^{\prime}f^{\alpha}{}_{\alpha}-2\,t_1\,\partial_{\prime}f^{\alpha\prime}\,\partial_{\theta}f_{\alpha}{}^{\theta}+4\,t_1\,\partial^{\prime}f^{\alpha}{}_{\alpha}\,\partial_{\theta}f_{\prime}{}^{\theta}+$$
$$\partial^{\prime}f^{\alpha}{}_{\alpha}-2\,t_1\,\partial_{\prime}f^{\alpha\prime}\,\partial_{\theta}f_{\alpha}{}^{\theta}+4\,t_1\,\partial^{\prime}f^{\alpha}{}_{\alpha}\,\partial_{\theta}f_{\prime}{}^{\theta}+$$
$$4\,t_1\;\omega_{\prime\theta\alpha}\;\partial^{\theta}f^{\alpha\prime}-4\,t_1\,\partial_{\alpha}f_{\prime\theta}\,\partial^{\theta}f^{\alpha\prime}+2\,t_2\,\partial_{\alpha}f_{\prime\theta}\,\partial^{\theta}f^{\alpha\prime}-$$
$$4\,t_1\;\omega_{\prime\theta\alpha}\;\partial^{\theta}f^{\alpha\prime}-4\,t_1\,\partial_{\alpha}f_{\prime\theta}\,\partial^{\theta}f^{\alpha\prime}+2\,t_2\,\partial_{\alpha}f_{\prime\theta}\,\partial^{\theta}f^{\alpha\prime}-$$
$$4\,t_1\,\partial_{\alpha}f_{\theta\prime}\,\partial^{\theta}f^{\alpha\prime}+2\,t_1\,\partial_{\prime}f_{\alpha\theta}\,\partial^{\theta}f^{\alpha\prime}-t_2\,\partial_{\prime}f_{\alpha\theta}\,\partial^{\theta}f^{\alpha\prime}+$$
$$4\,t_1\,\partial_{\theta}f_{\alpha\prime}\,\partial^{\theta}f^{\alpha\prime}+2\,t_1\,\partial_{\theta}f_{\prime\alpha}\,\partial^{\theta}f^{\alpha\prime}-t_2\,\partial_{\theta}f_{\prime\alpha}\,\partial^{\theta}f^{\alpha\prime}+$$
$$2\,(t_1+t_2)\;\omega_{\alpha\prime\theta}\,(\omega^{\alpha\prime\theta}+2\,\partial^{\theta}f^{\alpha\prime})+2\;\omega_{\alpha\theta\prime}\;((t_1-2\,t_2)\;\omega^{\alpha\prime\theta}+2\,(2\,t_1-t_2)\,\partial^{\theta}f^{\alpha\prime})+$$
$$8\,r_2\,\partial_{\beta}\omega_{\alpha\theta\prime}\,\partial^{\theta}\omega^{\alpha\beta\prime}+4\,r_2\,\partial_{\beta}\omega_{\prime\theta\alpha}\,\partial^{\theta}\omega^{\alpha\beta\prime}-2\,r_2\,\partial_{\prime}\omega_{\alpha\beta\theta}$$
$$\partial^{\theta}\omega^{\alpha\beta\prime}+2\,r_2\,\partial_{\theta}\omega_{\alpha\beta\prime}\,\partial^{\theta}\omega^{\alpha\beta\prime}-4\,r_2\,\partial_{\theta}\omega_{\alpha\prime\beta}\,\partial^{\theta}\omega^{\alpha\beta\prime}\Big)[t,x,y,z]\,dz\,dy\,dx\,dt$$

$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{i\,k\,(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$\frac{t_1+t_2}{3}$	$\frac{1}{3}\,i\,k\,(t_1+t_2)$	0	0	0	0
$-\frac{1}{3}\,i\,k\,(t_1+t_2)$	$\frac{1}{3}\,k^2\,(t_1+t_2)$	0	0	0	0
0	0	$\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}\,i\sqrt{2}\;kt_1$
0	0	0	0	0	0
0	0	$-\frac{1}{3}\,i\,kt_1$	$-\frac{1}{3}\,i\sqrt{2}\;kt_1$	0	$\frac{2k^2t_1}{3}$

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

$\omega_{1^+}^{\#1}{}_{\alpha\beta}\dagger^{\alpha\beta}$
$\frac{1}{6}\,(t_1+4\,t_2)$
$-\frac{t_1-2t_2}{3\sqrt{2}}$
$\frac{ik\,(t_1-2t_2)}{3\sqrt{2}}$
0
0
0
0

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

$\omega_{1^+}^{\#2}{}_{\alpha\beta}\dagger^{\alpha\beta}$
$-\frac{t_1-2t_2}{3\sqrt{2}}$
$\frac{t_1+t_2}{3}$
$-\frac{1}{3}\,i\,k\,(t_1+t_2)$
0
0
0
0

$f_{1^+}^{\#1}{}_{\alpha\beta}$

$f_{1^+}^{\#1}{}_{\alpha\beta}\dagger^{\alpha\beta}$
$-\frac{i\,k\,(t_1-2t_2)}{3\sqrt{2}}$
$\frac{1}{3}\,i\,k\,(t_1+t_2)$
$\frac{1}{3}\,k^2\,(t_1+t_2)$
0
0
0
0

$\omega_{1^-}^{\#1}{}_{\alpha}$

$\omega_{1^-}^{\#1}{}_{\alpha}\dagger^{\alpha}$
0
0
0
$\frac{t_1}{6}$
$\frac{t_1}{3\sqrt{2}}$
0
$-\frac{1}{3}\,i\,kt_1$

$\omega_{1^-}^{\#2}{}_{\alpha}$

$\omega_{1^-}^{\#2}{}_{\alpha}\dagger^{\alpha}$
0
0
0
$\frac{t_1}{3\sqrt{2}}$
$\frac{t_1}{3}$
0
$-\frac{1}{3}\,i\sqrt{2}\;kt_1$

$f_{1^-}^{\#1}{}_{\alpha}$

$f_{1^-}^{\#1}{}_{\alpha}\dagger^{\alpha}$
0
0
0
0
0
0
0

$f_{1^-}^{\#2}{}_{\alpha}$

$f_{1^-}^{\#2}{}_{\alpha}\dagger^{\alpha}$
0
0
0
$\frac{ikt_1}{3}$
$\frac{1}{3}\,i\sqrt{2}\;kt_1$
0
$\frac{2k^2t_1}{3}$

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

$\omega_{0^+}^{\#1}\dagger$
0
0
0
$k^2\,r_2+t_2$

$f_{0^+}^{\#1}$

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

$f_{0^+}^{\#2}$

$f_{0^+}^{\#2}\dagger$
0
0
0
0

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

$\omega_{0^+}^{\#1}\dagger$
0
0
0
$k^2\,r_2+t_2$

$\sigma_{0^-}^{\#1}$

$\sigma_{0^-}^{\#1}\dagger$
0
0
0
$\frac{1}{k^2\,r_2+t_2}$

$\tau_{0^+}^{\#2}$

$\tau_{0^+}^{\#2}\dagger$
0
0
0
0

$\tau_{0^+}^{\#1}$

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

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

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

$\sigma_{0^-}^{\#1}$

$\sigma_{0^-}^{\#1}\dagger$
0
0
0
$\frac{1}{k^2\,r_2+t_2}$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} == 0$	1
$\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\;\sigma_{1^-}^{\#1\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\sigma_{1^-}^{\#1\,\alpha} == \sigma_{1^-}^{\#2\,\alpha}$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\;\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	3
$\tau_{2^+}^{\#1\,\alpha\beta} - 2\,i\,k\;\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	20

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

$\omega_{0^+}^{\#1}\dagger$	$f_{0^+}^{\#1}\dagger$	$f_{0^+}^{\#2}\dagger$	$\omega_{0^+}^{\#1}\dagger$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$k^2\,r_2+t_2$

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

$\sigma_{0^+}^{\#1}\dagger$	$\tau_{0^+}^{\#1}\dagger$	$\tau_{0^+}^{\#2}\dagger$	$\sigma_{0^-}^{\#1}\dagger$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2\,r_2+t_2}$

$\omega_{2^+}^{\#1}{}_{\alpha\beta}$ / $f_{2^+}^{\#1}{}_{\alpha\beta}$ / $\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$

$\omega_{2^+}^{\#1}\dagger^{\alpha\beta}$	$f_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$
$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$\frac{ikt_1}{\sqrt{2}}$	$k^2\,t_1$	0
0	0	$\frac{t_1}{2}$

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

$\sigma_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\tau_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$
$\frac{2}{(1+2k^2)^2\,t_1}$	$-\frac{2\,i\sqrt{2}\,k}{(1+2k^2)^2\,t_1}$	0
$\frac{2\,i\sqrt{2}\,k}{(1+2k^2)^2\,t_1}$	$\frac{4k^2}{(1+2k^2)^2\,t_1}$	0
0	0	$\frac{2}{t_1}$

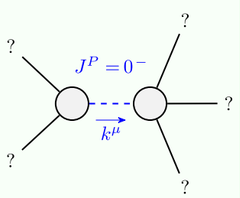
$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$

$\sigma_{2^+}^{\#1}\dagger^{\alpha\beta}$
$\frac{2}{(1+2k^2)^2\,t_1}$
$\frac{2\,i\sqrt{2}\,k}{(1+2k^2)^2\,t_1}$
0

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

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

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

$r_2 < 0$ && $t_2 > 0$