Particle spectrograph

Wave operator and propagator

	$\tau_{1^-\ \alpha}^{\#1}$	$\tau_{1^-\ \alpha}^{\#2}$	$\sigma_{1^-\ \alpha}^{\#1}$	$\sigma_{1^-\ \alpha}^{\#2}$
$\sigma_{1^+}^{\#1\ \dagger\ \alpha\beta}$	0	0	0	0
$\sigma_{1^+}^{\#2\ \dagger\ \alpha\beta}$	0	0	0	0
$\tau_{1^+}^{\#1\ \dagger\ \alpha\beta}$	0	0	0	0
$\sigma_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	$\frac{2(t_1+t_3)}{3t_1t_3+2k^2(r_1+r_5)(t_1+t_3)}$	$\frac{\sqrt{2}(t_1-2t_3)}{3t_1t_3+2k^2(r_1+r_5)(t_1+t_3)}$
$\sigma_{1^-}^{\#2\ \dagger\ \alpha}$	0	0	$\frac{\sqrt{2}(t_1-2t_3)}{3t_1t_3+2k^2(r_1+r_5)(t_1+t_3)}$	$\frac{6k^2(r_1+r_5)+t_1+4t_3}{(1+2k^2)(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$
$\tau_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	0	0
$\tau_{1^-}^{\#2\ \dagger\ \alpha}$	0	0	$\frac{2ik(t_1-2t_3)}{3t_1t_3+2k^2(r_1+r_5)(t_1+t_3)}$	$\frac{ik\sqrt{2}(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$

	$\sigma_{1^+\ \alpha\beta}^{\#1}$	$\sigma_{1^+\ \alpha\beta}^{\#2}$	$\tau_{1^+\ \alpha\beta}^{\#1}$
$\sigma_{1^+}^{\#1\ \dagger\ \alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$-\frac{ik\sqrt{2}}{t_1+k^2t_1}$
$\sigma_{1^+}^{\#2\ \dagger\ \alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{-2k^2(2r_1+r_5)+t_1}{(1+k^2)^2t_1^2}$	$\frac{-2ik^3(2r_1+r_5)+ikt_1}{(1+k^2)^2t_1^2}$
$\tau_{1^+}^{\#1\ \dagger\ \alpha\beta}$	$\frac{ik\sqrt{2}}{t_1+k^2t_1}$	$\frac{ik(2k^3(2r_1+r_5)-kt_1)}{(1+k^2)^2t_1^2}$	$\frac{-2k^4(2r_1+r_5)+k^2t_1}{(1+k^2)^2t_1^2}$
$\sigma_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	0
$\sigma_{1^-}^{\#2\ \dagger\ \alpha}$	0	0	0
$\tau_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	0
$\tau_{1^-}^{\#2\ \dagger\ \alpha}$	0	0	0

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} - 2ik\,\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} + 2ik\,\sigma_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + ik\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	3
$\tau_{2^+}^{\#1\,\alpha\beta} - 2ik\,\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	16

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1\ \dagger}$	$\frac{1}{(1+2k^2)^2t_3}$	$-\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_3}$	0	0
$\tau_{0^+}^{\#1\ \dagger}$	$\frac{i\sqrt{2}\,k}{(1+2k^2)^2t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$	0	0
$\tau_{0^+}^{\#2\ \dagger}$	0	0	0	0
$\sigma_{0^-}^{\#1\ \dagger}$	0	0	0	$-\frac{1}{t_1}$

	$\omega_{2^+\ \alpha\beta}^{\#1}$	$f_{2^+\ \alpha\beta}^{\#1}$	$\omega_{2^-\ \alpha\beta\chi}^{\#1}$
$\omega_{2^+}^{\#1\ \dagger\ \alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1\ \dagger\ \alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	k^2t_1	0
$\omega_{2^-}^{\#1\ \dagger\ \alpha\beta\chi}$	0	0	$k^2r_1+\frac{t_1}{2}$

	$\sigma_{2^+\ \alpha\beta}^{\#1}$	$\tau_{2^+\ \alpha\beta}^{\#1}$	$\sigma_{2^-\ \alpha\beta\chi}^{\#1}$
$\sigma_{2^+}^{\#1\ \dagger\ \alpha\beta}$	$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2t_1}$	0
$\tau_{2^+}^{\#1\ \dagger\ \alpha\beta}$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2t_1}$	$\frac{4k^2}{(1+2k^2)^2t_1}$	0
$\sigma_{2^-}^{\#1\ \dagger\ \alpha\beta\chi}$	0	0	$\frac{2}{2k^2r_1+t_1}$

	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$	$f_{0^+}^{\#1}$	$\omega_{0^+}^{\#1}$
$\omega_{0^+}^{\#1\ \dagger}$	0	0	0	t_3
$f_{0^+}^{\#1\ \dagger}$	0	0	$-i\sqrt{2}\,kt_3$	$i\sqrt{2}\,kt_3$
$f_{0^+}^{\#2\ \dagger}$	0	0	$2k^2t_3$	0
$\omega_{0^-}^{\#1\ \dagger}$	0	$-t_1$	0	0

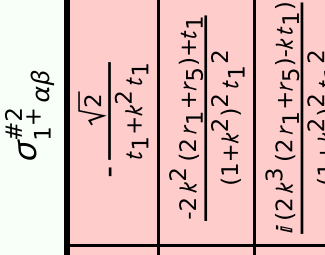
	$\omega_{1^-\ \alpha}^{\#1}$	$\omega_{1^-\ \alpha}^{\#2}$	$f_{1^-\ \alpha}^{\#1}$	$f_{1^-\ \alpha}^{\#2}$
$\omega_{1^+}^{\#1\ \dagger\ \alpha\beta}$	0	0	0	0
$\omega_{1^+}^{\#2\ \dagger\ \alpha\beta}$	0	0	0	0
$f_{1^+}^{\#1\ \dagger\ \alpha\beta}$	0	0	0	0
$\omega_{1^-}^{\#1\ \dagger\ \alpha}$	$k^2(2r_1+r_5)+t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{1}{3}ik(t_1-2t_3)$	$\frac{2}{3}k^2(t_1+t_3)$
$\omega_{1^-}^{\#2\ \dagger\ \alpha}$	$-\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	$\frac{1}{3}i\sqrt{2}\,k(t_1+t_3)$	0
$f_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	0	0
$f_{1^-}^{\#2\ \dagger\ \alpha}$	$-\frac{1}{3}ik(t_1-2t_3)$	$-\frac{1}{3}i\sqrt{2}\,k(t_1+t_3)$	0	0

	$\omega_{1^+\ \alpha\beta}^{\#1}$	$\omega_{1^+\ \alpha\beta}^{\#2}$	$f_{1^+\ \alpha\beta}^{\#1}$
$\omega_{1^+}^{\#1\ \dagger\ \alpha\beta}$	$k^2(2r_1+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$
$\omega_{1^+}^{\#2\ \dagger\ \alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0
$f_{1^+}^{\#1\ \dagger\ \alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	0	0
$\omega_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	$\frac{1}{6}(6k^2(r_1+r_5)+t_1+4t_3)$
$\omega_{1^-}^{\#2\ \dagger\ \alpha}$	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$
$f_{1^-}^{\#1\ \dagger\ \alpha}$	0	0	$\frac{t_1+t_3}{3}$
$f_{1^-}^{\#2\ \dagger\ \alpha}$	0	0	$-\frac{1}{3}ik(t_1-2t_3)$

Quadratic (free) action

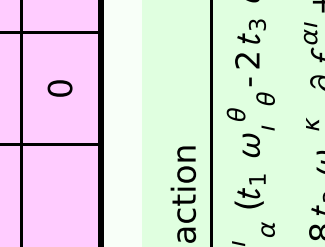
$$S == \int\int\int\int(\tfrac{1}{6}(2\,\omega^{\alpha\prime}{}_{\alpha}{}^{\theta}(t_1\,\omega_{\prime}{}^{\theta}{}_{\theta}-2t_3\,\omega_{\prime}{}^{\kappa}{}_{\kappa})+6\,f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}-$$
$$4t_1\,\omega_{\alpha}{}^{\theta}{}_{\theta}\,\partial_{\prime}f^{\alpha\prime\prime}+8t_3\,\omega_{\alpha}{}^{\kappa}{}_{\kappa}\,\partial_{\prime}f^{\alpha\prime\prime}+4t_1\,\omega_{\prime}{}^{\theta}{}_{\theta}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-8t_3\,\omega_{\prime}{}^{\kappa}{}_{\kappa}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-$$
$$2t_1\,\partial_{\prime}f^{\theta}{}_{\theta}\partial^{\prime}f^{\alpha}{}_{\alpha}+4t_3\,\partial_{\prime}f^{\kappa}{}_{\kappa}\,\partial^{\prime}f^{\alpha}{}_{\alpha}-2t_1\,\partial_{\prime}f^{\alpha\prime\prime}\,\partial_{\theta}f_{\prime}{}^{\theta}+4t_1\,\partial^{\prime}f^{\alpha}{}_{\alpha}\,\partial_{\theta}f_{\prime}{}^{\theta}-$$
$$6t_1\,\partial_{\alpha}f_{\prime\theta}\partial^{\theta}f^{\alpha\prime\prime}-3t_1\,\partial_{\alpha}f_{\theta\prime}\,\partial^{\theta}f^{\alpha\prime\prime}+3t_1\,\partial_{\theta}f_{\alpha\prime}\,\partial^{\theta}f^{\alpha\prime\prime}+$$
$$3t_1\,\partial_{\theta}f_{\prime\alpha}\partial^{\theta}f^{\alpha\prime\prime}+6t_1\,\omega_{\alpha\theta\prime}\,(\omega^{\alpha\prime\theta}+2\,\partial^{\theta}f^{\alpha\prime\prime})-8r_1\,\partial_{\theta}\omega_{\alpha\beta\prime}\partial^{\theta}\omega^{\alpha\beta\prime}+4r_1\,\partial_{\theta}\omega_{\alpha\theta\prime}\partial^{\theta}\omega^{\alpha\beta\prime}-16r_1\,\partial_{\beta}\omega_{\prime\theta\alpha}\partial^{\theta}\omega^{\alpha\beta\prime}-4r_1\,\partial_{\prime}\omega_{\alpha\theta\beta}\partial^{\theta}\omega^{\alpha\beta\prime}+$$
$$\partial^{\theta}\omega^{\alpha\beta\prime}+4r_1\,\partial_{\theta}\omega_{\alpha\prime\beta}\partial^{\theta}\omega^{\alpha\beta\prime}+6r_5\,\partial_{\prime}\omega_{\theta}{}^{\kappa}\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}{}^{\kappa}-6r_5\,\partial_{\theta}\omega_{\prime}{}^{\kappa}\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}{}^{\kappa}+$$
$$4t_3\,\partial_{\prime}f^{\alpha\prime\prime}\partial_{\kappa}f_{\alpha}{}^{\kappa}-8t_3\,\partial^{\prime}f^{\alpha}{}_{\alpha}\partial_{\kappa}f_{\prime}{}^{\kappa}-6r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\partial_{\kappa}\omega_{\prime}{}^{\kappa}{}_{\theta}+$$
$$6r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime}-12r_5\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime}))[t,x,y,z]\,dz\,dy\,dx\,dt$$

Massive and massless spectra



Massive particle

Pole residue:	$-\frac{3(-2t_1t_3(t_1+t_3)+r_1(t_1{}^2+2t_3{}^2)+r_5(t_1{}^2+2t_3{}^2))}{2(r_1+r_5)(t_1+t_3)(-3t_1t_3+r_1(t_1+t_3)+r_5(t_1+t_3))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_3}{2(r_1+r_5)(t_1+t_3)} > 0$
Spin:	1
Parity:	Odd



Massive particle

Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_1 < 0$ && $r_5 < -r_1$ && $t_1 > 0$ && $t_3 < -t_1$ || $t_3 > 0$