

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \uparrow^{\alpha\beta}$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\sigma_{1+}^{\#1} \uparrow^{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{i\sqrt{2}k}{t_1+k^2}t_1$	0	0	0
$\sigma_{1+}^{\#2} \uparrow^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2}t_1$	$-\frac{2k^2r_5+t_1}{(1+k^2)^2}t_1^2$	$-\frac{i(2k^3r_5-kt_1)}{(1+k^2)^2}t_1^2$	0	0	0
$\tau_{1+}^{\#1} \uparrow^{\alpha\beta}$	$\frac{i\sqrt{2}k}{t_1+k^2}t_1$	$\frac{i(2k^3r_5-kt_1)}{(1+k^2)^2}t_1^2$	$\frac{-2k^4r_5+k^2t_1}{(1+k^2)^2}t_1^2$	0	0	0
$\sigma_{1-}^{\#1} \uparrow^{\alpha}$	0	0	0	$-\frac{2(t_1+t_3)}{3t_1t_3+2k^2r_5(t_1+t_3)}$	$-\frac{\sqrt{2}(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2r_5(t_1+t_3))}$	$-\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2r_5(t_1+t_3))}$
$\sigma_{1-}^{\#2} \uparrow^{\alpha}$	0	0	0	$-\frac{\sqrt{2}(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2r_5(t_1+t_3))}$	$\frac{6k^2r_5+t_1+4t_3}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$	$\frac{i\sqrt{2}k(6k^2r_5+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$
$\tau_{1-}^{\#1} \uparrow^{\alpha}$	0	0	0	0	0	0
$\tau_{1-}^{\#2} \uparrow^{\alpha}$	0	0	0	$-\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2r_5(t_1+t_3))}$	$-\frac{i\sqrt{2}k(6k^2r_5+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$	$-\frac{2k^2(6k^2r_5+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2r_5(t_1+t_3))}$

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

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

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

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

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

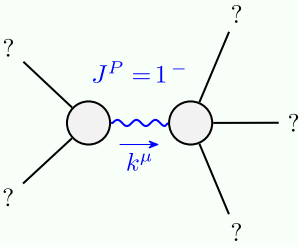
Quadratic (free) action

$$S = \iiint (\frac{1}{6}(2\omega_{\alpha}^{\alpha'}(t_1\omega_{,\theta}^{\theta}-2t_3\omega_{,\kappa}^{\kappa})+6f^{\alpha\beta}\tau_{\alpha\beta}+6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}-4t_1\omega_{\alpha}^{\theta}\partial_{,f}f^{\alpha}+8t_3\omega_{\alpha}^{\kappa}\omega_{\kappa}^{\alpha'}\partial_{,f}f^{\alpha'}+4t_1\omega_{,\theta}^{\theta}\omega_{,\kappa}^{\kappa}\partial_{,f}f^{\alpha}-8t_3\omega_{,\kappa}^{\kappa}\partial_{,f}f^{\alpha}-2t_1\partial_{,f}f^{\theta}\partial_{,\theta}f^{\alpha}+4t_3\partial_{,f}f_{\kappa}^{\kappa}\partial_{,\theta}f_{\theta}^{\theta}-2t_1\partial_{,f}f_{\alpha}^{\alpha'}\partial_{,\theta}f_{\alpha}^{\alpha'}+4t_1\partial_{,f}f_{\alpha}^{\alpha'}\partial_{,\theta}f_{\theta}^{\theta}-6t_1\partial_{,\alpha}f_{,\theta}\partial^{\theta}f^{\alpha}-3t_1\partial_{\alpha}f_{\theta,\theta}\partial^{\theta}f^{\alpha'}+3t_1\partial_{,\theta}f_{\alpha,\alpha'}\partial^{\theta}f^{\alpha'}+3t_1\partial_{,\theta}f_{,\alpha}\partial^{\theta}f^{\alpha'}+6t_1\omega_{\alpha\theta,\theta}(\omega^{\alpha\theta}+2\partial^{\theta}f^{\alpha'})+6r_5\partial_{,\theta}\omega_{\theta,\kappa}^{\kappa}\partial^{\theta}\omega_{,\kappa}^{\kappa}-6r_5\partial_{\theta}\omega_{,\kappa}^{\kappa}\partial^{\theta}\omega_{\alpha}^{\alpha'}+4t_3\partial_{,f}f_{\alpha}^{\alpha'}\partial_{,\kappa}^{\kappa}\partial_{,\alpha}f_{\alpha}^{\alpha'}\partial_{,\kappa}^{\kappa}-6r_5\partial_{\alpha}\omega_{,\theta}^{\theta}\partial_{,\kappa}^{\kappa}\omega_{,\theta}^{\theta}+12r_5\partial^{\theta}\omega_{,\theta}^{\theta}\partial_{,\alpha}\omega_{,\kappa}^{\kappa}+6r_5\partial_{\alpha}\omega^{\alpha\theta}\partial_{,\kappa}^{\kappa}\omega_{,\theta}^{\theta}-12r_5\partial^{\theta}\omega_{,\theta}^{\theta}\partial_{,\kappa}^{\kappa}\omega_{,\theta}^{\theta})) [t, x, y, z] dz dy dx dt$$

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

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{6t_1t_3(t_1+t_3)-3r_5(t_1^2+2t_3^2)}{2r_5(t_1+t_3)(-3t_1t_3+r_5(t_1+t_3))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_3}{2r_5t_1+2r_5t_3} > 0$
Spin:	1
Parity:	Odd

No massless particles (see picture)

Unitarity conditions

$r_5 < 0 \&\& (t_1 < 0 \&\& 0 < t_3 < -t_1) || (t_1 > 0 \&\& (t_3 < -t_1 || t_3 > 0))$