

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\frac{2(t_1+t_2)}{3t_1t_2+2k^2r_5(t_1+t_2)}$	$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2r_5(t_1+t_2))}$	$\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2r_5(t_1+t_2))}$	0	0	0	0
$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2r_5(t_1+t_2))}$	$\frac{6k^2r_5+t_1+4t_2}{(1+k^2)^2(3t_1t_2+2k^2r_5(t_1+t_2))}$	$\frac{ik(6k^2r_5+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2r_5(t_1+t_2))}$	0	0	0	0
$-\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2r_5(t_1+t_2))}$	$-\frac{ik(6k^2r_5+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2r_5(t_1+t_2))}$	$\frac{k^2(6k^2r_5+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2r_5(t_1+t_2))}$	0	0	0	0
0	0	0	$\sigma_{1-}^{\#1} \dagger^{\alpha}$	$\sigma_{1-}^{\#2} \alpha$	0	$\frac{2ik}{t_1+2k^2t_1}$
0	0	0	$\sigma_{1-}^{\#2} \dagger^{\alpha}$	$\sigma_{1-}^{\#1} \alpha$	0	$-\frac{i\sqrt{2}k(2k^2r_5-t_1)}{(t_1+2k^2t_1)^2}$
0	0	0	$\tau_{1-}^{\#1} \dagger^{\alpha}$	$\tau_{1-}^{\#1} \alpha$	0	0
0	0	0	$\tau_{1-}^{\#2} \dagger^{\alpha}$	$\tau_{1-}^{\#2} \alpha$	$-\frac{2ik}{t_1+2k^2t_1}$	$\frac{-4k^4r_5+2k^2t_1}{(t_1+2k^2t_1)^2}$

Quadratic (free) action

$$S_F = \iiint \left(\frac{1}{6} (-6t_1\omega_{\kappa\alpha}^{\alpha'}\omega_{\kappa\alpha}^{\kappa}-2(t_1-2t_2)\omega_{\kappa\lambda}^{\kappa\lambda}\omega_{\kappa\lambda}^{\prime}+2t_1\omega_{\kappa\lambda}^{\prime}\omega_{\kappa\lambda}^{\prime}+\right. \\ \left.2t_2\omega_{\kappa\lambda}^{\prime}\omega_{\kappa\lambda}^{\kappa\lambda}+6f^{\alpha\beta}\tau_{\alpha\beta}+6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}-6r_5\partial_\theta\omega_{\lambda\alpha}^\alpha\partial_\kappa\omega_{\lambda\alpha}^{\theta\kappa\lambda}-6r_5\partial_\alpha\omega_{\lambda\theta}^\alpha\partial_\kappa\omega_{\lambda\theta}^{\kappa\lambda\theta}+ \right. \\ \left.12r_5\partial_\theta\omega_{\lambda\alpha}^\alpha\partial_\kappa\omega_{\lambda\alpha}^{\kappa\lambda\theta}-2t_1\partial^\alpha f_{\theta\kappa}\partial^\kappa f_\alpha^\theta+t_2\partial^\alpha f_{\theta\kappa}\partial^\kappa f_\alpha^\theta-4t_1\partial^\alpha f_{\kappa\theta}\partial^\kappa f_\alpha^\theta- \right. \\ \left. t_2\partial^\alpha f_{\kappa\theta}\partial^\kappa f_\alpha^\theta-2t_1\partial^\alpha f_{\kappa}^\lambda\partial^\kappa f_{\alpha\lambda}^\theta+t_2\partial^\alpha f_{\kappa}^\lambda\partial^\kappa f_{\alpha\lambda}^\theta+6t_1\omega_{\kappa\alpha}^\alpha\partial^\kappa f_{\alpha\lambda}^{\prime}+ \right. \\ \left. 6t_1\omega_{\kappa\lambda}^\lambda\partial^\kappa f_{\alpha\lambda}^{\prime}+12t_1\partial^\alpha f_{\kappa\alpha}\partial^\kappa f_{\alpha\lambda}^{\prime}-6t_1\partial_\kappa f_{\alpha\lambda}^{\prime}\partial^\kappa f_{\alpha\lambda}^{\prime}+2t_1\omega_{\theta\kappa}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}+ \right. \\ \left. 2t_2\omega_{\theta\kappa}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}+8t_1\omega_{\kappa\theta}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}-4t_2\omega_{\kappa\theta}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}-2t_1\omega_{\theta\kappa}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}- \right. \\ \left. 2t_2\omega_{\theta\kappa}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}+4t_1\omega_{\theta\kappa\lambda}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}+4t_2\omega_{\theta\kappa\lambda}\partial^\kappa f_{\alpha\lambda}^{\prime\theta}-6t_1\omega_{\alpha\lambda}^\alpha\partial^\kappa f_{\kappa}^{\prime}- \right. \\ \left. 6t_1\omega_{\alpha\lambda}^\lambda\partial^\kappa f_{\kappa}^{\prime}+2t_1\partial^\alpha f_{\kappa}^\lambda\partial^\kappa f_{\lambda\alpha}^\theta-t_2\partial^\alpha f_{\kappa}^\lambda\partial^\kappa f_{\lambda\alpha}^\theta+2t_1\partial_\kappa f_{\theta}^\lambda\partial^\kappa f_{\lambda}^\theta- \right. \\ \left. t_2\partial_\kappa f_{\theta}^\lambda\partial^\kappa f_{\lambda}^\theta+4t_1\partial_\kappa f_{\theta}^\lambda\partial^\kappa f_{\lambda}^\theta+t_2\partial_\kappa f_{\theta}^\lambda\partial^\kappa f_{\lambda}^\theta-6t_1\partial^\alpha f_{\alpha}^\lambda\partial^\kappa f_{\lambda\kappa}^\theta+ \right. \\ \left. 6r_5\partial_\alpha\omega_{\lambda\theta}^\alpha\partial^\lambda\omega_{\theta\kappa}^{\theta\kappa}-6r_5\partial_\theta\omega_{\lambda\alpha}^\alpha\partial^\lambda\omega_{\lambda\alpha}^{\theta\kappa}\right)[t,x,y,z]dzdydxdt$$

	$\omega_{1+}^{\#1} \alpha\beta$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$\omega_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{1}{6}(6k^2r_5+t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} \dagger^{\alpha\beta}$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}ik(t_1+t_2)$	0	0	0	0
$f_{1+}^{\#1} \dagger^{\alpha\beta}$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}ik(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$	0	0	0	0
$\omega_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	$k^2r_5-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	ikt_1
$\omega_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$-ikt_1$	0	0	0

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

$\sigma_{0+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{0+}^{\#1} \alpha\beta$	$\tau_{0+}^{\#1} \alpha\beta$	$\tau_{0+}^{\#2} \sigma_0^{\#1}$
$-\frac{1}{(1+2k^2)^2}t_1$	$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	0
$-\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	$-\frac{2k^2}{(1+2k^2)^2}t_1$	$-\frac{2k^2}{(1+2k^2)^2}t_1$	0
0	0	0	0
0	0	0	$\frac{1}{t_2}$

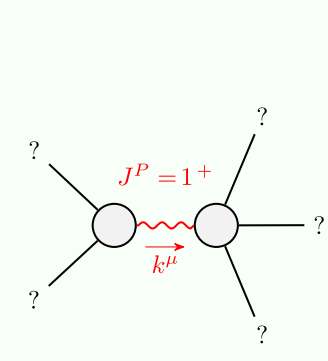
$\omega_{0+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{0+}^{\#1} \alpha\beta$	$f_{0+}^{\#1} \alpha\beta$	$f_{0+}^{\#2} \omega_0^{\#1}$
-t_1	$i\sqrt{2}kt_1$	0	0
$-i\sqrt{2}kt_1$	$-2k^2t_1$	0	0
0	0	0	0
0	0	0	t_2

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

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

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{-3t_1t_2(t_1+t_2)+3r_5(t_1^2+2t_2^2)}{r_5(t_1+t_2)(-3t_1t_2+2r_5(t_1+t_2))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_2}{2r_5t_1+2r_5t_2} > 0$
Spin:	1
Parity:	Even

(No massless particles)

Unitarity conditions

$r_5 > 0 \ \&\& \ (t_1 < 0 \ \&\& \ (t_2 < 0 \ || \ t_2 > -t_1)) \ || \ (t_1 > 0 \ \&\& \ -t_1 < t_2 < 0)$