

Particle spectrograph

Wave operator and propagator

	$\sigma_{1+}^{\#1} \alpha\beta$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\sigma_{1+}^{\#1} \uparrow \alpha\beta$	$\frac{2(t_1+t_2)}{3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2)}$	$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0	0	0
$\sigma_{1+}^{\#2} \uparrow \alpha\beta$	$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{6k^2(2r_1+r_5)+t_1+4t_2}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{i k (6 k^2 (2 r_1 + r_5) + t_1 + 4 t_2)}{(1 + k^2)^2 (3 t_1 t_2 + 2 k^2 (2 r_1 + r_5) (t_1 + t_2))}$	0	0	0	0
$\tau_{1+}^{\#1} \uparrow \alpha\beta$	$-\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$-\frac{i k (6 k^2 (2 r_1 + r_5) + t_1 + 4 t_2)}{(1 + k^2)^2 (3 t_1 t_2 + 2 k^2 (2 r_1 + r_5) (t_1 + t_2))}$	$-\frac{k^2 (6 k^2 (2 r_1 + r_5) + t_1 + 4 t_2)}{(1 + k^2)^2 (3 t_1 t_2 + 2 k^2 (2 r_1 + r_5) (t_1 + t_2))}$	0	0	0	0
$\sigma_{1-}^{\#1} \uparrow \alpha$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	0	$\frac{2ik}{t_1+2k^2t_1}$
$\sigma_{1-}^{\#2} \uparrow \alpha$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{-2k^2(r_1+r_5)+t_1}{(t_1+2k^2t_1)^2}$	0	$-\frac{i\sqrt{2}k(2k^2(r_1+r_5)-t_1)}{(t_1+2k^2t_1)^2}$
$\tau_{1-}^{\#1} \uparrow \alpha$	0	0	0	0	0	0	0
$\tau_{1-}^{\#2} \uparrow \alpha$	0	0	0	$-\frac{2ik}{t_1+2k^2t_1}$	$\frac{i\sqrt{2}k(2k^2(r_1+r_5)-t_1)}{(t_1+2k^2t_1)^2}$	0	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$

	$\omega_{1+}^{\#1} \alpha\beta$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$\omega_{1+}^{\#1} \uparrow \alpha\beta$	$\frac{1}{6}(6k^2(2r_1+r_5)+t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$-\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} \uparrow \alpha\beta$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	$\frac{1}{3}ik(t_1+t_2)$	0	0	0	0
$f_{1+}^{\#1} \uparrow \alpha\beta$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3}ik(t_1+t_2)$	$\frac{1}{3}k^2(t_1+t_2)$	0	0	0	0
$\omega_{1-}^{\#1} \uparrow \alpha$	0	0	0	$k^2(r_1+r_5)-\frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	$ik t_1$
$\omega_{1-}^{\#2} \uparrow \alpha$	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0
$f_{1-}^{\#1} \uparrow \alpha$	0	0	0	0	0	0	0
$f_{1-}^{\#2} \uparrow \alpha$	0	0	0	$-ik t_1$	0	0	0

$\omega_{2+}^{\#1} \uparrow \alpha\beta$	$\frac{t_1}{2}$	$-\frac{ik t_1}{\sqrt{2}}$	0
$f_{2+}^{\#1} \uparrow \alpha\beta$	$\frac{ik t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega_{2+}^{\#1} \uparrow \alpha\beta_X$	0	0	$k^2 r_1 + \frac{t_1}{2}$

Source constraints/gauge generators	Multiplicities
SO(3) irreps	
$\tau_{0+}^{\#2} == 0$	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

$\omega_{0+}^{\#1} \uparrow$	$-t_1$	$i\sqrt{2}kt_1$	0	0
$f_{0+}^{\#1} \uparrow$	$-i\sqrt{2}kt_1$	$-2k^2t_1$	0	0
$f_{0+}^{\#2} \uparrow$	0	0	0	0
$\omega_{0-}^{\#1} \uparrow$	0	0	0	t_2

$\sigma_{2+}^{\#1} \uparrow \alpha\beta$	$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	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
$\sigma_{2-}^{\#1} \uparrow \alpha\beta_X$	0	0	$\frac{2}{2k^2r_1+t_1}$

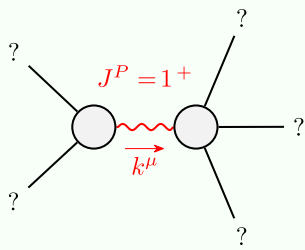
$\sigma_{0+}^{\#1} \uparrow$	$-\frac{1}{(1+2k^2)^2t_1}$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	0	0
$\tau_{0+}^{\#1} \uparrow$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	$-\frac{2k^2}{(1+2k^2)^2t_1}$	0	0
$\tau_{0+}^{\#2} \uparrow$	0	0	0	0
$\sigma_{0-}^{\#1} \uparrow$	0	0	0	$\frac{1}{t_2}$

Quadratic (free) action

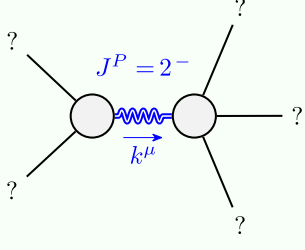
$S=$

$$\iiint\iiint(\frac{1}{6}(6t_1\omega^{\alpha i}_{ \alpha}\omega^{\theta}_{ \theta}+6f^{\alpha\beta}\tau_{\alpha\beta}+6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}-12t_1\omega^{\theta}_{ \alpha}\partial_{ \theta}f^{\alpha i}+12t_1\omega^{\theta}_{ \theta}\partial'f^{\alpha}_{ \alpha}-6t_1\partial_{ \theta}f^{\theta}_{ \theta}\partial'f^{\alpha}_{ \alpha}-6t_1\partial_{ \theta}f^{\alpha i}\partial_{ \theta}f^{\theta}_{ \alpha}+12t_1\partial'f^{\alpha}_{ \alpha}\partial_{ \theta}f^{\theta}_{ \theta}+4t_1\omega_{ \theta\alpha}\partial^{\theta}f^{\alpha i}+4t_2\omega_{ \theta\alpha}\partial^{\theta}f^{\alpha i}-4t_1\partial_{ \theta}f^{\alpha i}\partial_{ \theta}f^{\theta}_{ \alpha}+2t_2\partial_{ \theta}f^{\alpha i}\partial_{ \theta}f^{\theta}_{ \alpha}-4t_1\partial_{ \theta}f^{\theta}_{ \alpha}\partial^{\theta}f^{\alpha i}-t_2\partial_{ \theta}f^{\theta}_{ \alpha}\partial^{\theta}f^{\alpha i}+2t_1\partial_{ \theta}f^{\alpha\theta}\partial^{\theta}f^{\alpha i}-t_2\partial_{ \theta}f^{\alpha\theta}\partial^{\theta}f^{\alpha i}+4t_1\partial_{ \theta}f^{\alpha i}\partial^{\theta}f^{\alpha i}+t_2\partial_{ \theta}f^{\alpha i}\partial^{\theta}f^{\alpha i}+2t_1\partial_{ \theta}f^{\alpha i}\partial^{\theta}f^{\alpha i}-t_2\partial_{ \theta}f^{\alpha i}\partial^{\theta}f^{\alpha i}+2(t_1+t_2)\omega_{\alpha i\theta}(\omega^{\alpha i\theta}+2\partial^{\theta}f^{\alpha i})+2\omega_{\alpha\theta i}((t_1-2t_2)\omega^{\alpha i\theta}+2(2t_1-t_2)\partial^{\theta}f^{\alpha i})-8r_1\partial_{\beta}\omega_{\alpha i\theta}\partial^{\theta}\omega^{\alpha\beta i}+4r_1\partial_{\beta}\omega_{\alpha\theta i}\partial^{\theta}\omega^{\alpha\beta i}-16r_1\partial_{\beta}\omega_{i\theta\alpha}\partial^{\theta}\omega^{\alpha\beta i}-4r_1\partial_{ \theta} \omega_{\alpha\beta\theta}\partial^{\theta}\omega^{\alpha\beta i}+4r_1\partial_{\theta}\omega_{\alpha\beta i}\partial^{\theta}\omega^{\alpha\beta i}+4r_1\partial_{\theta}\omega_{\alpha i\beta}\partial^{\theta}\omega^{\alpha\beta i}+6r_5\partial_{ \theta} \omega_{\theta}^{\kappa}\partial^{\theta}\omega^{\alpha i}_{ \alpha}-6r_5\partial_{\theta}\omega_{i \kappa}^{\kappa}\partial^{\theta}\omega^{\alpha i}_{ \alpha}-6r_5\partial_{\alpha}\omega^{\alpha i\theta}\partial_{\kappa}\omega_{i \theta}^{\kappa}+12r_5\partial^{\theta}\omega^{\alpha i}_{ \alpha}\partial_{\kappa}\omega_{i \theta}^{\kappa}+6r_5\partial_{\alpha}\omega^{\alpha i\theta}\partial_{\kappa}\omega_{\theta i \kappa}^{\kappa}-12r_5\partial^{\theta}\omega^{\alpha i}_{ \alpha}\partial_{\kappa}\omega_{\theta i \kappa}^{\kappa})) [t, x, y, z] dz dy dx dt$$

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{-3t_1t_2(t_1+t_2)+6r_1(t_1^2+2t_2^2)+3r_5(t_1^2+2t_2^2)}{(2r_1+r_5)(t_1+t_2)(-3t_1t_2+4r_1(t_1+t_2)+2r_5(t_1+t_2))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_2}{2(2r_1+r_5)(t_1+t_2)} > 0$
Spin:	1
Parity:	Even



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

$r_1 < 0 \&\& r_5 > -2r_1 \&\& t_1 > 0 \&\& -t_1 < t_2 < 0$