

Particle spectrograph

Wave operator and propagator

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

Quadratic (free) action

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

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

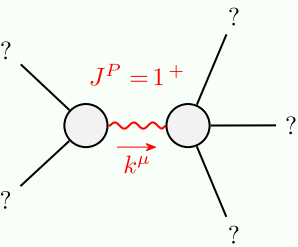
$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2+}^{\#1} \alpha\beta$	$\tau_{2+}^{\#1} \alpha\beta$	$\sigma_{2+}^{\#1} \alpha\beta\chi$
$\frac{2}{(1+2k^2)^2t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0	0
$\tau_{2+}^{\#1} \dagger^{\alpha\beta}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2t_1}$	0	0
$\sigma_{2+}^{\#1}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

$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#1} \dagger$	$f_{0+}^{\#2} \dagger$	$\omega_{0+}^{\#1} \dagger$
-t ₁	$i\sqrt{2}kt_1$	0	0
$-i\sqrt{2}kt_1$	-2k ² t ₁	0	0
0	0	0	0
0	0	0	t ₂

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

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

(No massless particles)

Unitarity conditions

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